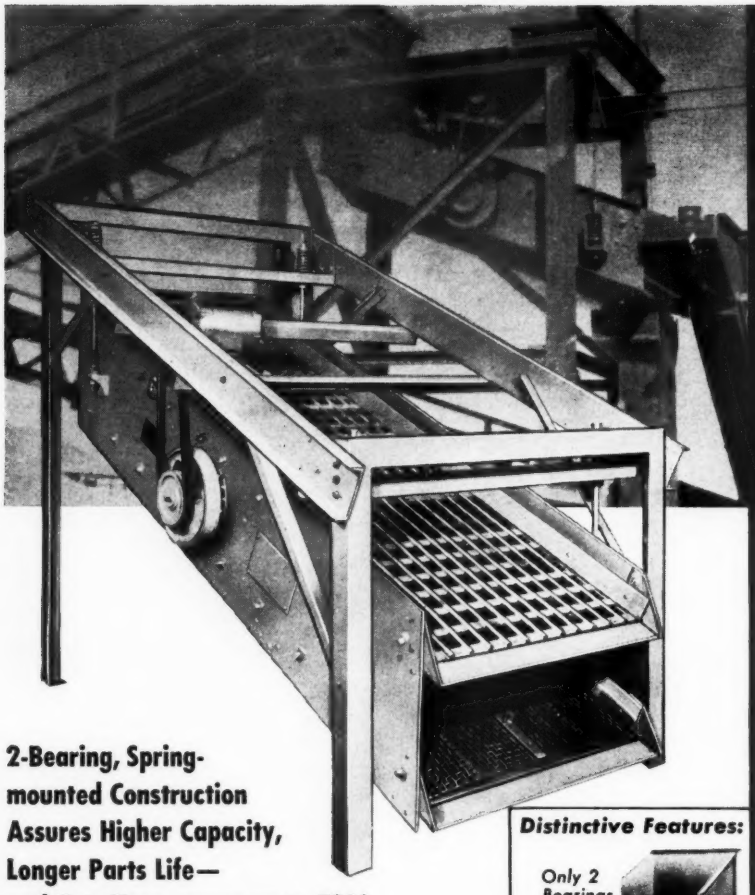
Mining CONGRESS JOURNAL

AMC

DECEMBER 1937

God rest ye Merry Gentlemen

DENVER-DILLON Vibrating SCREENS



2-Bearing, Spring-mounted Construction Assures Higher Capacity, Longer Parts Life— and Cuts Horsepower up to 50%

LOW POWER REQUIRED. Weight of screen and material being screened supported entirely on spring-mounted suspension rods. Only weight on the bearings is the vibrating mechanisms. Bearings are not subjected to shock loads. Horsepower needed cut up to 50%.

NO DAMPING UNDER LOADS. Entire mechanism is free floating—not tied to supporting framework through outboard bearings. No damping even under heaviest loads. Efficiency remains high and constant.

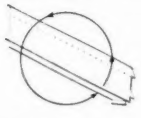
UNIFORM VIBRATION—HIGHER CAPACITY. Full-Floating mechanism transmits uniform TRUE CIRCLE vibration to every part of screen. No dead spots. Constant, full-screen efficiency gives highest capacity and longest screen life.

SAVES COST—SAVES SPACE. Elimination of unnecessary parts—heavy outer bearings and frames—reduces overall weight of Denver-Dillon Vibrating Screens by 30% to 50%. Width is considerably reduced. Cost is lower—space requirements are lower—than for 4-bearing types.

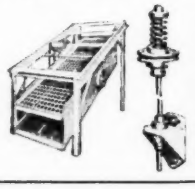
Distinctive Features:

Only 2 Bearings

Floating Circle Action



Suspended Construction



IN STOCK FOR QUICK DELIVERY

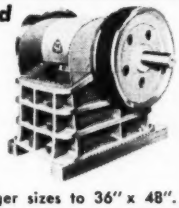
On hand is a wide range of Standard Denver-Dillon Vibrating Screens to assure you quick delivery.

Available in double deck types, either floor mounted or with suspension frame, sizes from 1' x 3' to 6' x 14'—or special types to meet individual needs—there's a Denver-Dillon Screen to answer your screen problems.

Find out how a Denver-Dillon can cut your screening costs, increase your profits. Write, wire or phone. Flowsheets for every screening job on request. Ask for Bulletin S3 B15.

DENVER *Forced-Feed* JAW CRUSHERS

IN STOCK



Denver forced-feed crushers have anti-friction pitman and side bearings. Cast steel frame on 10" by 20" and smaller sizes, welded steel frame on larger sizes to 36" x 48". Jaw plates can be inverted for longer wear. Forced feed plus extra long jaws assure highest capacity.

C. A. Richardson, DECO Sales Engineer, is available to assist you with your screening problems. You will appreciate prompt attention to the details which are essential to your satisfaction. Write today!

"The firm that makes its friends happier, healthier and wealthier"

DECO ENGINEERS — DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

DENVER EQUIPMENT CO.

1400 Seventeenth St. • Denver 17, Colorado

DENVER • NEW YORK • CHICAGO • VANCOUVER • TORONTO

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Mining

CONGRESS JOURNAL

DECEMBER, 1957

VOLUME 43 NUMBER 12

CONTENTS

FRONT COVER—In the Spirit of the Holiday Season MINING CONGRESS JOURNAL Wishes All Its Readers a Very MERRY CHRISTMAS and a HAPPY NEW YEAR.

Opinions expressed by authors within these pages are their own and do not necessarily represent those of the American Mining Congress

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Indexed regularly by Engineering Index, Inc.

New flat stranding of grounding conductor prevents broken wires—assures continuity of operation. Full 50% wire delivers maximum electrical protection.

Only Anaconda's flat 50% grounding wire offers full electrical protection—with small diameter

It takes a full 50% grounding wire to give you needed electrical protection. Anaconda's Securityflex* Shuttle Car Cable with its service-proven, *flat* grounding wire provides this protection!

Flat 50% wire, too, offers extra safeguard . . . will not cut insulation if cable is crushed by runovers. And it allows more cable on reel.

Millions of feet of Anaconda Securityflex Cable have been sold without a reported failure of grounding conductor. In addition, Securityflex offers . . .

3 NEW ADVANTAGES

1. Rugged high-grade *neoprene insulation* that greatly increases resistance to puncture, flame and crushing.

2. Improved stranding of ground and power conductors that prevents broken wires—assures continuity of ground and power conductors.

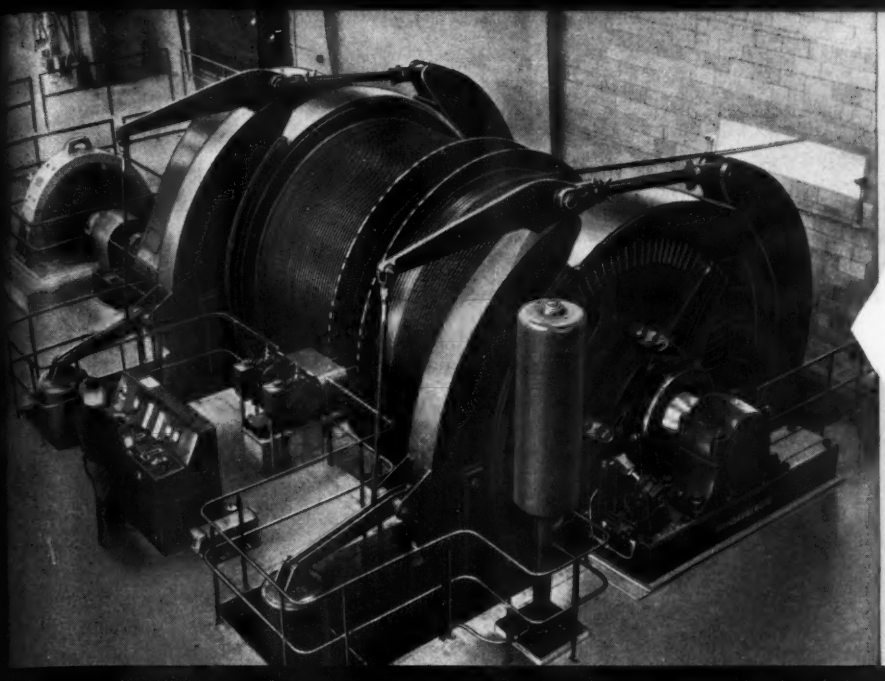
3. Nylon breaker strip that increases short-circuit protection . . . and nylon seine twine jacket reinforcement that prevents wicking of moisture, gives jacket greater tear resistance.

Insist on full-size grounding conductor for safety—insist on *Anaconda* Shuttle Car Cable. At *regular* prices. See the Man from Anaconda or your distributor. Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York.

57322

*Reg. U.S. Pat. Off.

ASK YOUR ANACONDA® DISTRIBUTOR FOR MINE CABLE



CONVENTIONAL DRUM HOISTS

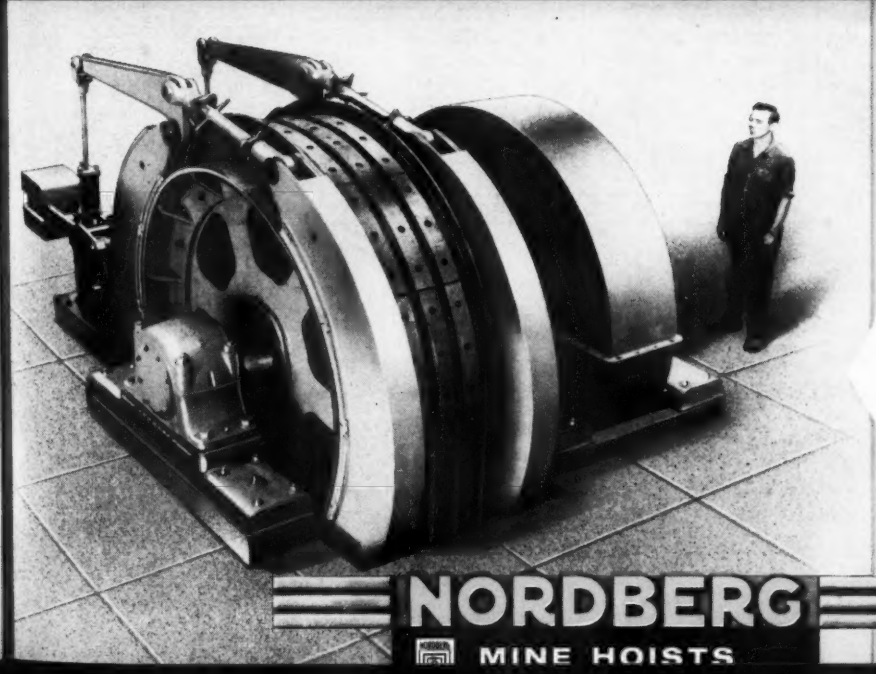
Typical of the large hoisting machinery built by Nordberg is this conventional 12′ diameter by 84″ face double drum ore hoist which serves a prominent iron producer. This hoist is designed for a depth of 2800 feet, using 10-ton skips and hoisting 14 long tons of ore at a rope speed of 2000 feet per minute.

Nordberg hoists are available for manual, push-button semi-automatic, or fully automatic control.

NORDBERG'S 61 YEARS of MINE HOIST EXPERIENCE can help you select the best hoist to meet your requirements

▶ Why not let over half a century of specialized mine hoist experience help you select the *right* type and size hoist to meet your specific operational requirements?

With the trend toward larger tonnages and more powerful hoists, greater emphasis must be placed on the proven experience and ability of the hoist manufacturer. Here, Nordberg has an established reputation second to none, and can furnish both conventional and friction type hoists. This wide experience is at the call of mine executives everywhere. *Consult Nordberg on your next hoist problem.*



FRICTION TYPE HOISTS

Where applicable, the hoisting of ore, men or materials can be economically handled with Nordberg Friction Hoists . . . built for either counterweighted skip or skips-in-balance operation. Manual, push-button semi-automatic, or fully automatic control available. Outstanding features of the Nordberg design include: One-piece welded steel drum; anti-friction roller bearings throughout; pressure applied—pressure released hydraulic brakes with emergency gravity application.

Illustrated is a 4-rope hoist designed for push-button semi-automatic, multi-level operation, to handle men and material.

NORDBERG MFG. CO.
Milwaukee 1, Wis.

NORDBERG
MINE HOISTS

©1957, Nordberg Mfg. Co.

MH157

NEW RESULTS OF MONSANTO RESEARCH IN USE OF AMMONIUM NITRATE AS AN EXPLOSIVE

Typical shot with Monsanto's new kind of prilled NH_4NO_3

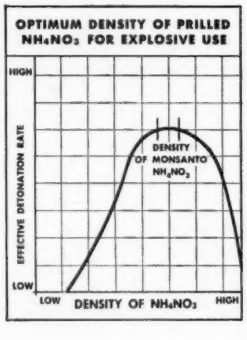
View of area involved in the blast. Shot was made in heavy columnar basalt at dam site. Used as an explosive: a new, top-quality, prilled NH_4NO_3 that Monsanto research developed to give you optimum savings, safety, speed and ease of handling.

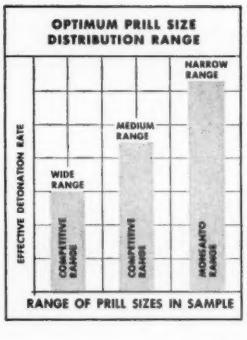
View at time of detonation. The system of detonation recommended by Monsanto, in conjunction with Monsanto Ammonium Nitrate, will yield equivalent pound-for-pound results with 60% gelatin dynamite at one-fourth the cost.

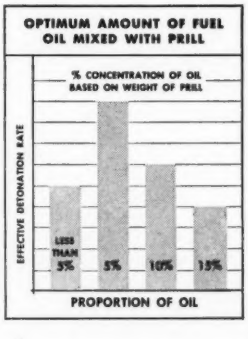
Results of blast. The powder factor in the shot above was 0.4 lbs. per cubic yard. Breakage of rock was considered ideal by contractor. Monsanto's experienced staff can give you complete technical service. Just phone Monsanto.

Photos courtesy of MORRISON-KNUDSEN COMPANY, INC.

Monsanto Ammonium Nitrate is now produced according to the specifications determined by these findings of Monsanto research. Result: more effective blast at greater savings. Monsanto is the world's largest manufacturer of prilled ammonium nitrate—and leader in developing the use of NH_4NO_3 as an explosive for open work. Request report presenting latest research findings.







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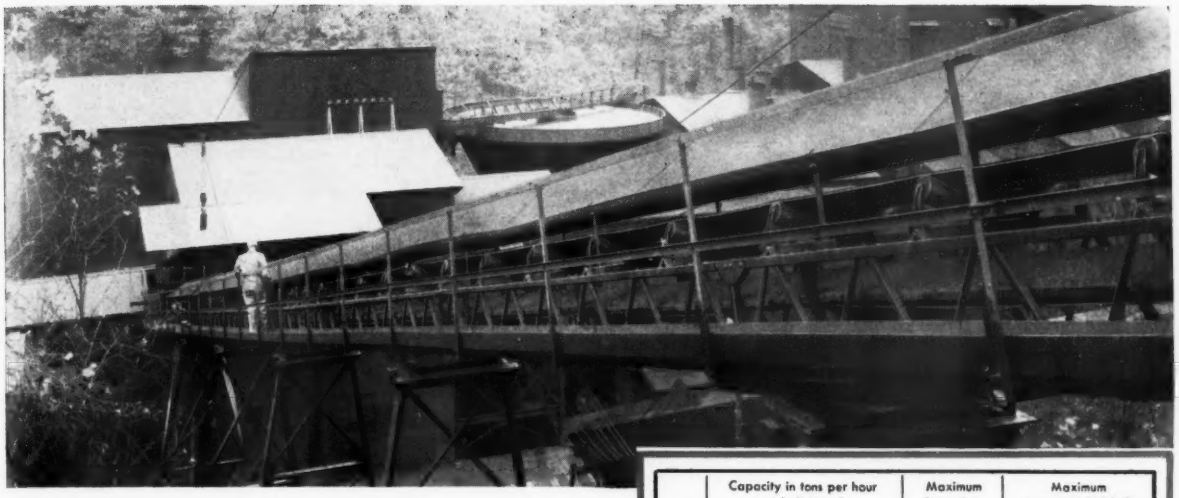
Where Creative Chemistry Works Wonders For You

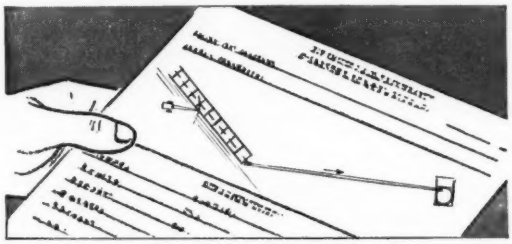


For lower costs down the line
make your belt conveyors

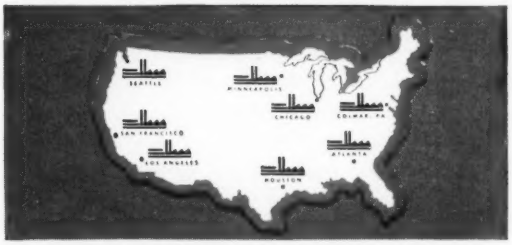
PRE-BILT by LINK-BELT

Belt width, inches	Capacity in tons per hour at belt speed of 100 FPM			Maximum lump size, inches		Maximum recommended belt speed, FPM	
	Weight of material, lbs. per cu.ft.			Sized	Unsized	Half maximum size lumps	Maximum size lumps
	50	75	100				
18	27	40.5	54	3	5	400	300
24	50	75.0	100	4½	8	500	400
30	81	121.5	162	7	10	600	450
36	117	176.0	235	8	14	650	500

EASY SELECTION. Your Link-Belt engineer will help you choose the best combination from a wide selection of PRE-BILT sectional belt conveyor components.



PROMPT ESTIMATES. From standardized data, an "on-the-site" quotation can be prepared covering the components for your needs.



SPEEDY DELIVERY. Standardized parts are shipped from the nearest of 8 plants. One-source availability eliminates the delay of coordinating purchases from several suppliers.

FAST INSTALLATION. Due to simple construction and shop-assembled components, you can do your own erecting. Link-Belt also furnishes complete erection service and supervision.

Link-Belt PRE-BILT sectional belt conveyors combine operating efficiency and economy to give you years of dependable, profitable operation.

For full information on these durable conveyors up to 36 in. wide—with drives up to 40 hp, 24 and 42-inch truss depths—contact your nearby Link-Belt office, or send for Book 2579.

LINK-BELT

BELT CONVEYORS

14,702

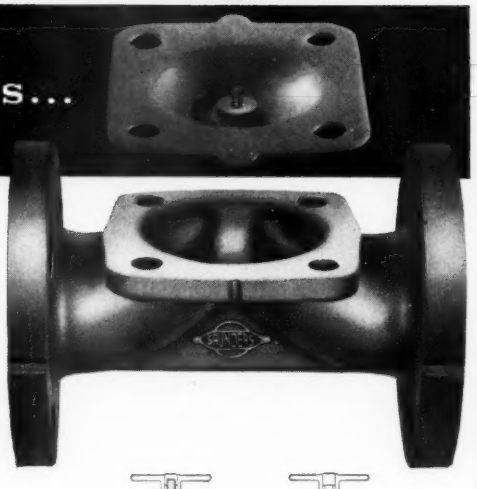
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

Outperforms other valves under SEVERE chemical conditions

GRINNELL-SAUNDERS DIAPHRAGM VALVES

Backing Cushion

with TEFLON Diaphragms...

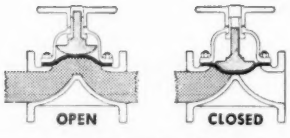


Grinnell Teflon Diaphragms are made by a special process which produces a better product of greater density, toughness and flex life.

The four case histories cited below demonstrate that Teflon offers a very high degree of chemical inertness to some of the most difficult chemicals which industry today must handle. Yet these are only a few of many success stories in the Grinnell files.

Diaphragm life depends on temperature, pressure and frequency of operation. Inquiries must include complete service data to receive prompt and careful attention.

Service Conditions	Saunders Valve Now Used	Service Life: Teflon Diaphragm	Service Life: Previous Valve
Case 1. Benzene hexachloride (30%-40% benzene, free chlorine); 120 to 130 F, 10 to 20 psi; operated 3 to 4 times daily	Glass lined bodies; Teflon Diaphragm; 1 to 3 inches	10 to 14 mos.	1 to 2 mos.
Case 2. 90%-95% HNO_3 plus 1.8% HF (specific gravity 1.62—1.77) 115 F in summer; 40 F in winter; 125 psi; operated 2 to 3 times daily	Durimet 20 body; Teflon Diaphragm; 1 to 3 inches	8 months	2 months
Case 3. $AlCl+_2$ complex; ambient to 220 F; 0-50 psi; operated 1 to 2 times daily	Glass lined bodies; Teflon Diaphragms; 1 to 4 inches	9 months	6 months
Case 4. Sulphuric acid 85%; outside temperature; no pressure; operated 4 times daily	Iron bodies; Teflon Diaphragms; 2½ inches	Still in service after 1 year	3 weeks



Features of Grinnell-Saunders Diaphragm Valves

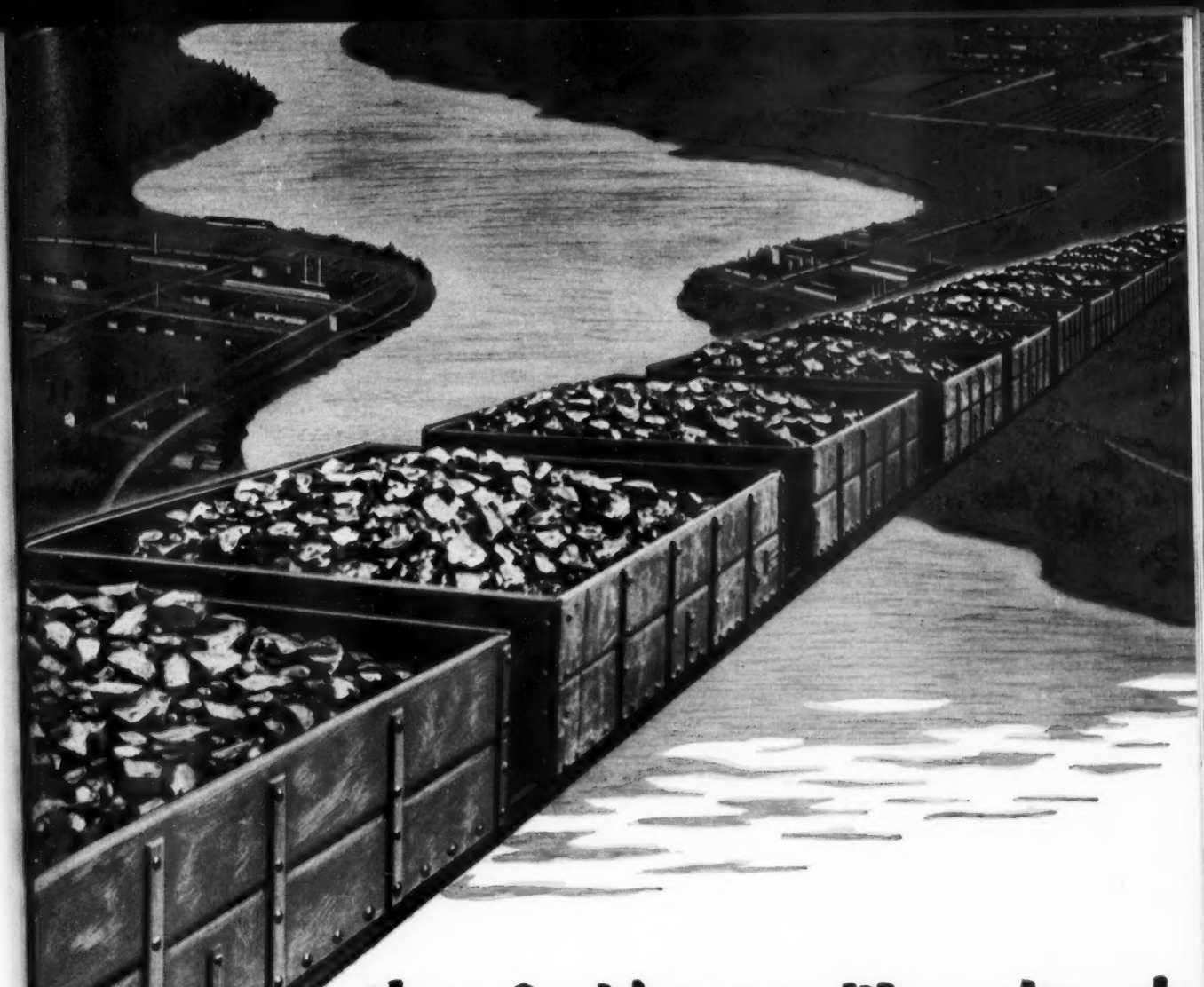
- Diaphragm lifts high for streamline flow in either direction.
- Resilient diaphragm assures positive, leak-tight closure even with grit or scale in the line.
- Diaphragm absolutely isolates working parts from fluid . . . sticking, clogging, contamination, corrosion eliminated.
- Body, linings and diaphragm materials to suit service conditions.
- Simple maintenance. Diaphragm can be replaced easily without removing valve from the line. No packing glands to demand attention. No metal-to-metal seats to become damaged or wire-drawn.

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



...they just keep rolling along!

acf mine cars for non-stop production

Like Old Man River, an acf Mine Car System just keeps rolling, delivering the tonnage with never an interruption. If a car needs repairs, you just shunt it aside... and the rest of the trip keeps right on hauling.

And mine car systems don't tie you down to a limited production rate; for more production merely use more cars. As you advance the face, just add new trackage, without stopping production. No expensive, complicated maintenance, either. Your own maintenance men can keep an acf Mine Car System healthy and productive. Cost and production figures recorded by operators prove the many advantages of acf Constant Haulage Mine Car Systems. Ask your acf representative for full information. Just write, wire, or phone any acf office.

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Division of acf Industries, Incorporated

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acf MINE CARS *for Constant Haulage*

New from Standard Oil

RYKON

GREASE

Standard scores major breakthrough in grease technology to bring you better lubrication... help you make important savings in grease use, application and inventorying.

Scientists at Standard Oil have developed a new non-soap, organic, grease thickening agent. This, plus other improvements in grease formulation, is now available in a new line of Standard greases named RYKON.

Mechanical stability—RYKON Greases show little change in consistency even under severe working.

Oxidation stability—Exclusive thickener in RYKON Greases inhibits oxygen absorption. This prevents costly corrosive action on bearings.

Water resistance—Extremely resistant to water washout.

High temperature stability—RYKON Greases have an ASTM dropping point of 480° F. They have exceptional heat stability.

Resistance to change—RYKON Greases remain soft and grease-like at sustained high temperatures, continue to give thorough lubrication.

Low temperature stability—RYKON Greases work readily at low temperatures, lubricate from a cold start.

Oil separation—RYKON Greases exhibit strong resistance to bleeding.

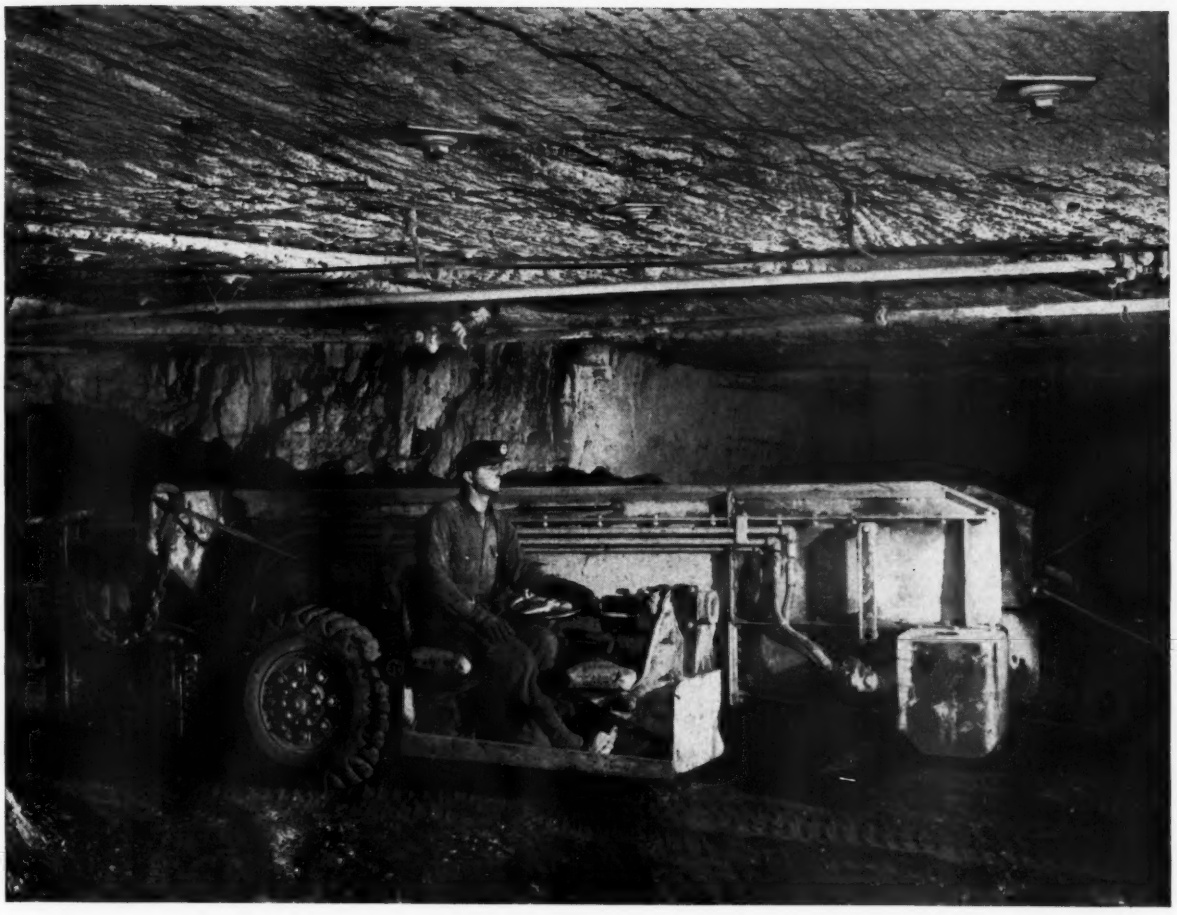
Rust preventive properties—RYKON Greases demonstrate superior natural qualities in prevention of rust.

To meet specific grease lubrication problems, greases in four Regular and three Heavy Duty grades are available. With a single RYKON multi-purpose grease doing all jobs in the plant, there's no wrong grease to use. Money invested in grease inventories is cut, storage and application facilities are reduced. Maintenance training is simplified.

Get the facts about RYKON Greases from the industrial lubrication specialist at the Standard Oil office nearest you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

STANDARD OIL COMPANY (Indiana)



How to bolt your roof...quickly

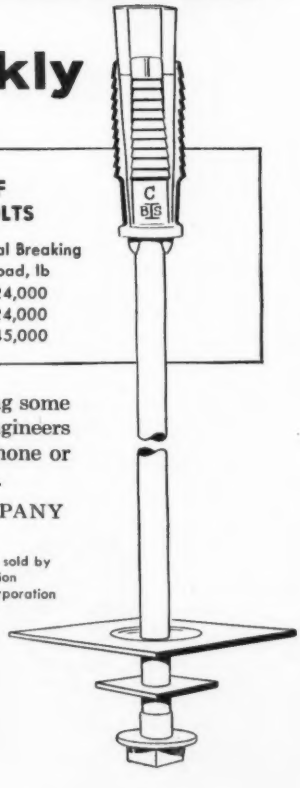
You can anchor your roof in jig time when you use Bethlehem square-head roof bolts equipped with expansion shells. Simply use your regular drilling equipment and an impact wrench.

Besides saving time, roof bolting does so much to promote safety by locking the overlying rock layers in place. With heavy timbers no longer taking up so much room, it's easier to move mechanized equipment. Ventilation is improved and fire hazards are reduced. And there's less need for large storage areas, both above and below ground.

The Bethlehem square-head roof bolt is used with a leaf-type malleable-iron shell, which is fastened to the leading end of the bolt. As the bolt is tightened in the hole, the leaves of the shell expand, locking the assembly in place. A square roof plate furnishes additional support. A hardened washer reduces friction which may occur between the bolt head and roof plate.

THREE TYPES OF SQUARE-HEAD BOLTS

Type	Diam. In.	Typical Breaking Load, lb
Carbon	¾	24,000
High-Strength	⅞	24,000
High-Strength	⅞	45,000



If you're thinking about doing some roof bolting, let one of our engineers give you full details. Just phone or write our nearest sales office.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

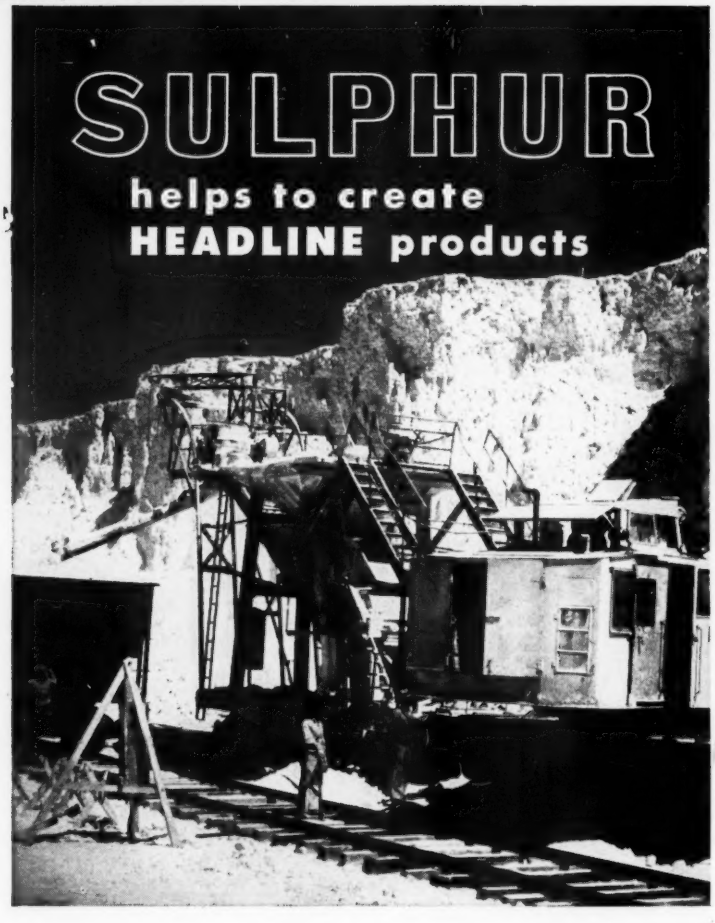
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

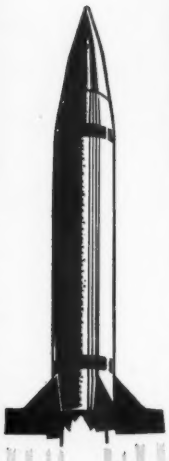
BETHLEHEM STEEL

BETHLEHEM STEEL

SULPHUR

helps to create HEADLINE products





Thiokol®

"Thiokol" synthetic rubber, is an organic polysulfide elastomer. One of its many uses is in solid propellents for long range and high altitude missiles. In liquid form, "Thiokol" synthetic rubber mixed with an oxidizer, is poured into specially designed combustion chambers of rockets. It helps to give stability to the fuel charge and resistance to shock. It promotes uniform burning. When the rocket motor is ignited the mixture burns with great intensity and generates large volumes of gas to propel the rocket.

Solid propellents made with "Thiokol" synthetic rubber have proved their value in rockets over liquid propellents in many ways: they are less costly and easier to manufacture—simple and rugged construction makes handling and launching easier and safer—fuel tanks and complicated feed systems are eliminated.

"Thiokol" synthetic rubber is a product containing a high percentage of Sulphur—its name being derived from the Greek words for sulphur and glue. Here is another example of the continually broadening field in which Sulphur is an important and necessary element.

**A trade name of Thiokol Chemical Corporation.*

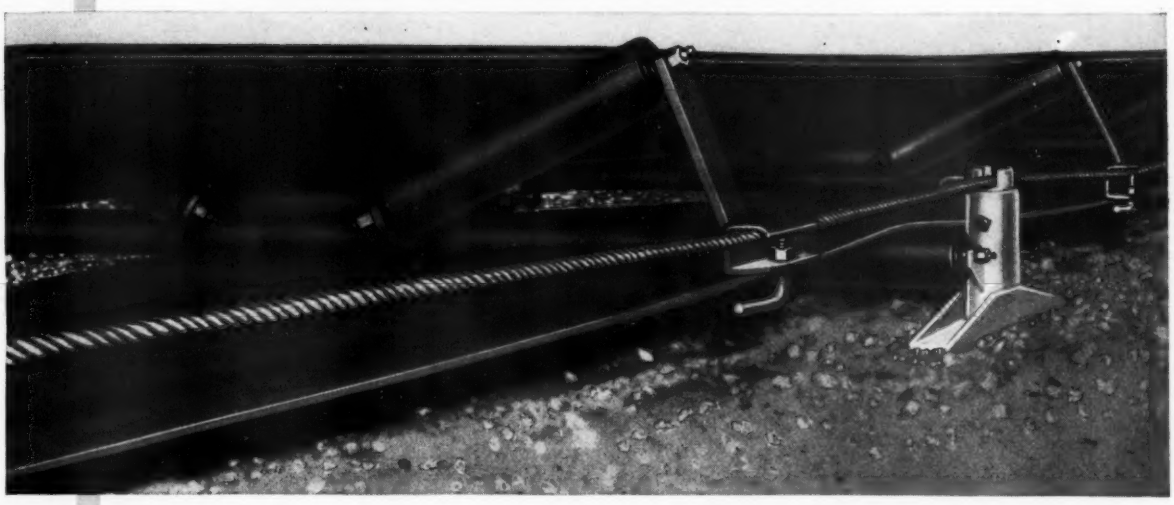
Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas

Sulphur Producing Units
- Newgulf, Texas
- Moss Bluff, Texas
- Spindletop, Texas
- Worland, Wyoming

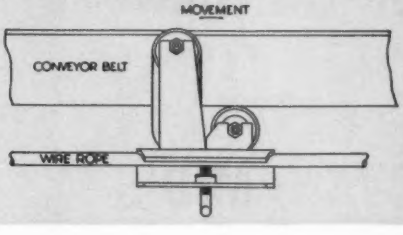
An Important New Development...

The LONG Lo-Rope BELT CONVEYOR



- **Automatic Self-Training** is provided since idlers rock in direction of belt travel.
- **Greater Safety** results as there are no side obstructions at level of carrying belt. Handling men and supplies is safe and easy.
- **Adjustable Height** rope supports minimize blocking—permit belt leveling in undulating bottom. Height adjustments for all seam thicknesses.
- **Greater head room for handling men in thin seams.** Carrying surface of belt may be as low as 9" from bottom.
- **Deep Trough design** reduces spillage and permits wider spacing between idlers.
- **Simpler, easier installation.** New type anchors have built-in tensioning device with quick acting rope clamps that permit use of continuous rope.
- **Overlapping rolls** eliminate possibility of belt edge contact with inside end of troughing rolls.

Lo-Rope Idler Assembly (Patent Applied For)



SELF-TRAINING... BOTH DIRECTIONS

The Lo-Rope troughing rolls and carrying belt are entirely above the rope side frame—any tipping movement of the troughing rolls is in the direction of belt travel. This gives a well-established, self-training effect *automatically* in *both* directions of travel.

This feature—the rocking movement on the rope as opposed to swinging—is an entirely new principle that offers important advantages not previously available.

For full information on LONG Lo-Rope Belt Conveyors or a demonstration, write us today

The LONG Company
Oak Hill, W. Va.

The industry's foremost specialists in conveyor mining machinery.

ANNOUNCING CYADYN* CYANAMID'S NEW LOW-COST CAP-SENSITIVE DYNAMITE

Only an electric blasting cap is needed to detonate this new Cyanamid explosive! Has a high density... and very good water resistance—all important features in an explosive for the construction, coal stripping and quarrying industries.

CYADYN also is finding wide use as an effective primer for low-cost blasting agents.

CYADYN comes in spiral-wrap cartridges of heavy cardboard for easy handling and loading into the blast hole. It has a stick count of 120 in 1¼″ x 8″... and is available in 4″, 4½″, 5″, 5½″, 6″ x 25# and 7″, 8″, 8½″ x 50#.

For CYADYN and other high-grade blasting materials and accessories, just contact your Cyanamid Representative. Cyanamid plants and magazines are conveniently located for quick delivery direct to your operation.

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EXPLOSIVES DEPARTMENT
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PRODUCTS: High Explosives · Permissibles · Blasting Agents · Blasting Powder · Blasting Caps · Electric Blasting Caps · Seismograph Explosives · Blasting Accessories

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from

Ingersoll-Rand

5-706 ♥ 11 Broadway, New York 4, N. Y.

It's the sensational

VACUJET ROOF BOLTING DUSTLESS STOPER

with built-in JET SUCTION
and PRESSURE DISCHARGE

In the new RP38E VACUJET dustless stoper, Ingersoll-Rand has perfected the first practical solution to the problem of dust control for roof bolting and other up-hole drilling operations. It's the *only* stoper that offers you all these important advantages.

Strong Suction Power — vacuum-producing jet ejector built into drill backhead. Can even drill horizontal holes!

Dust Discharged Under Pressure — to a distance of up to 25 ft from drill. Uses ordinary air hose.

Low-Cost Dust Collector — a simple filter and receptacle is all that's required. Even a canvas bag will do.

Quieter Operation — no unnecessary ear-splitting whine or howl in dust collection.

Highest Drilling Speed — because stronger vacuum and larger dust ports assure non-clogging operation.

Lower Bit, Rod and Shop Costs — tapered bit and rod connections eliminate need for furnaces, threading and forging equipment.

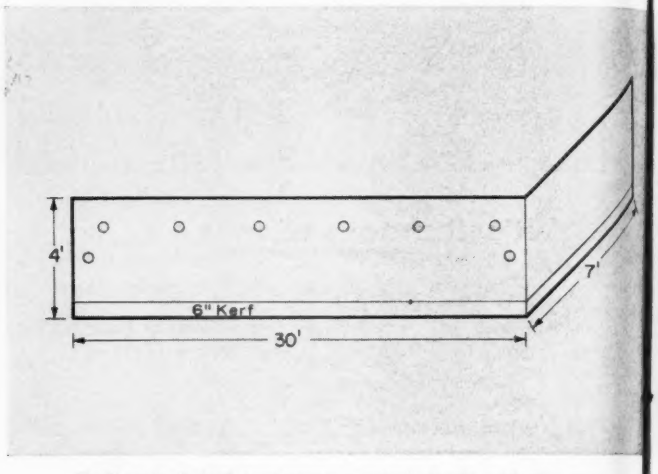
For the complete story on this revolutionary new VACUJET stoper, call your I-R man or send today for Bulletin No. 4195.

COMPRESSORS • CARSETS BITS • ALLOY RODS • HYDRA-BOOM JUMBOS
HOSE • JACKDRILLS • IMPACTOOLS

Mine foreman marking off shot holes prior to drilling. The undercut has already been completed. Note the clean face produced by the previous shot.

Loading out a fall of coal shot with Du Pont "Lump Coal" C, 1 ½ x 6, which produces a large percentage of coarse coal every time.

Coal on its way to the tipple. Uniform lump, quite evident here, is necessary for good loadability required when working on low profit margin.



Du Pont technical servicemen worked closely with the company to develop this shot pattern which produces maximum amount of coarse coal.

Du Pont "Lump Coal"® C maintains loadability needed for profitable operation

"We use Du Pont "Lump Coal" C permissible dynamite exclusively," says Mr. Sid Young, superintendent, Borderland Collieries Co., Borderland, Kentucky, "because it consistently gives the good loadability necessary for profitable operation.

"When working on a low margin of profit, it is mandatory that coal be moved from blasting point to shipping point at maximum speed. Any reduction in loadability would reduce or even eliminate our profit.

"Using Du Pont "Lump Coal" C, we consistently get the maximum amount of six- to nine-inch lump. It is this uniform lump size that permits fast loading."

In addition, "Lump Coal" C cleans the coal from the roof in hard-to-work sections. Dust has been reduced by 10% and crews can begin post-blast work promptly after the charge has been fired.

Call your Du Pont representative for more information or write E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., Wilmington 98, Delaware.

DU PONT PERMISSIBLES
Blasting Supplies and Accessories

DU PONT
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Better Things for Better Living . . . *through Chemistry*

SEE DU PONT SHOW OF THE MONTH ON CBS

MAX-WEAR ALLOY

makes parts like these last longer

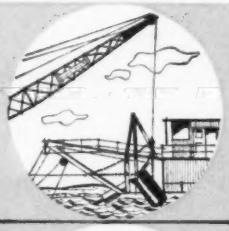
DREDGE BUCKET

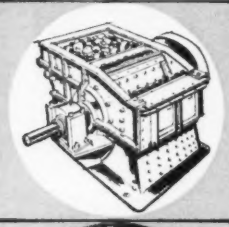
ROCK CRUSHER

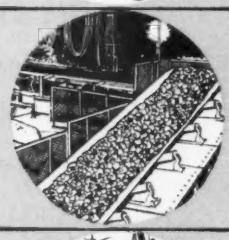
CHUTE LINING

WEAR PLATE

GROUSER BARS







—keeps equipment on the job

Max-Wear Alloy Steel (13% manganese, 2% nickel) is *work hardening!* This means the more it's used the harder the surface becomes (up to 500/550 BHN). But only the surface hardens; the interior of the steel is unaffected. As a result, Max-Wear parts have truly wear-resistant surfaces *plus* high strength and toughness internally.

When you make parts like those shown with Crucible Max-Wear, you reduce downtime, cut repair and replacement costs. For Max-Wear resists repeated heavy impacts and abrasion—just what you need on jobs where equipment takes a bad beating.

Crucible Max-Wear is especially practical for repairs in the field. It can be formed cold or at *red heat*, and is easily shear or torch cut and welded. No annealing is necessary after these operations—a big advantage in the field.

Max-Wear is now available in rounds, squares, plates and special grouser shapes. If you are looking for an easy-to-use alloy steel that will give you longer service under impact, wear and abrasion, try Crucible Max-Wear. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

for tough-screening jobs on construction sites, choose . . .

CF&I INDUSTRIAL SCREENS

Because they give you:

- **Maximum resistance to abrasion, vibration, fatigue**
- **Accurate screening**
- **Low downtime—long life . . . large tonnage output**

CF&I Industrial Screens can offer you all these advantages because they're made from specially selected steel that's crimped and woven extra tightly—to ensure high production even under the toughest operating conditions.

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THE COLORADO FUEL AND IRON CORPORATION

THE COLORADO FUEL AND IRON CORPORATION—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso Ft. Worth • Houston • Lincoln (Neb.) • Los Angeles • Oakland • Oklahoma City • Phoenix • Portland • Pueblo • Salt Lake City San Antonio • San Francisco • San Leandro • Seattle • Spokane • Wichita • **WICKWIRE SPENCER STEEL DIVISION**—Atlanta Boston • Buffalo • Chicago • Detroit • New Orleans • New York • Philadelphia • **CF&I OFFICES IN CANADA:** Montreal • Toronto

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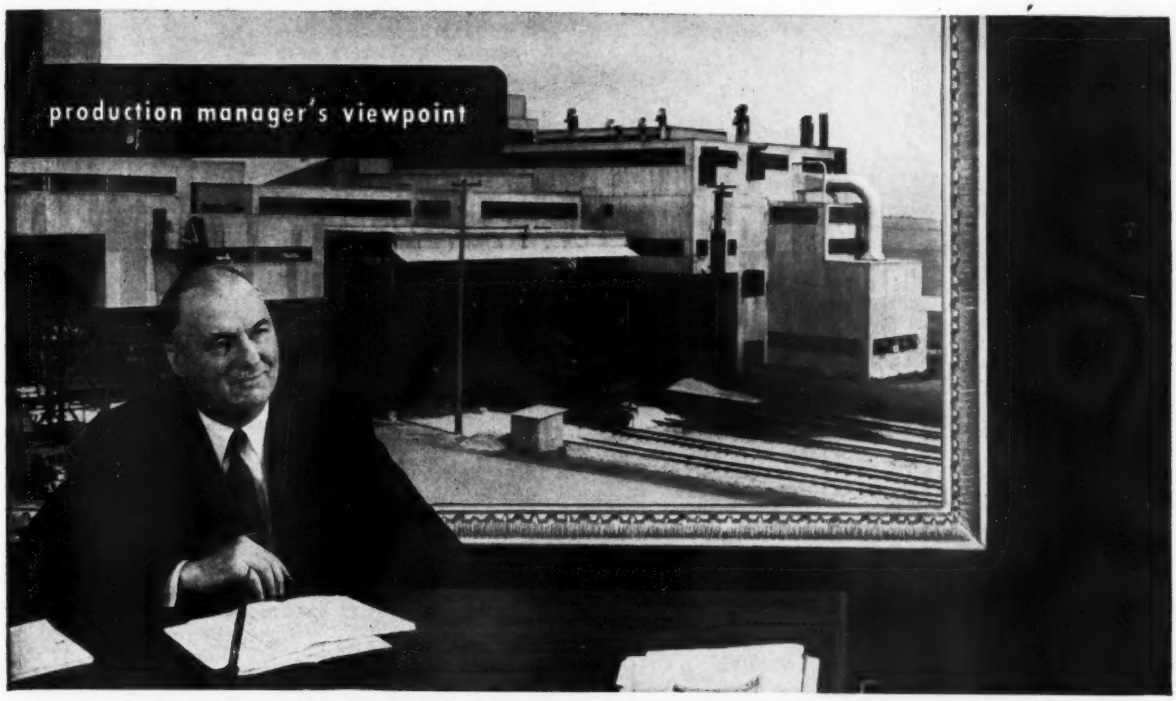

F. EARLE SNARR, VICE PRESIDENT-PRODUCTION OF FREEMAN COAL MINING CORPORATION SAYS

"WE WANT TOMORROW IN EVERY CLEANING PLANT WE BUILD TODAY"

When building a new preparation plant today we feel we cannot afford to have costly and time-consuming "bugs" upon completion, due to errors in planning. For this reason we like to employ engineers who are specialists in coal preparation plants. This method, we feel, gives us the benefit of broad knowledge and practical experience in methods and manufacturer's products to implement each process.

Tons of steel and its artful fabrication are important, but we prefer to look over the roster of a company's specialized personnel, its record of achievement and resourcefulness in its field.

We want tomorrow in every plant we build today.

F. Earle Snarr, Vice Pres.,
Production Freeman Coal Mining Corp

300 Years of Experience

The executives in charge of our engineering, coal preparation, construction and design departments, have spent a total of 300 years in the coal industry.

It's What We Do That's Important

Although Roberts & Schaefer Co., for fifty-two years, has been recognized as one of the pioneers in perfecting and manufacturing coal preparation plants, our services are not contingent upon what we make or sell.

Unbiased Recommendations

It is this unbiased viewpoint in our recommendations that has contributed to the successful operation of many of the largest and most modern preparation plants in the world.

EXPERIENCE

William C. McCulloch
Coal Preparation Manager

1922 Coal Washing Engineer Pacific Coast Coal Co. 1924 U.S. Bureau of Mines as Coal Mining Engineer. 1925 Laboratory Manager for Heyl & Patterson, Inc. 1930 Chief Chemist for Koppers Rheolaveur Co. 1935 Preparation Manager, United Electric Coal Companies. 1941 Coal Preparation Manager, Roberts & Schaefer Co. Holds master's degree in Coal Mining Engineering from University of Washington. U.S. Bureau of Mines fellowship at Northwest Experiment Station, Seattle, Washington. Member of American Institute of Mining Metallurgical and Petroleum Engineers, Illinois and West Virginia Mining Institutes and charter member of Illinois Society of Coal Preparation Engineers and Chemists. Member of Coal Advisory Committee of Illinois Geological Survey and recently member of the panel on Preparation of National Coal Association.

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ROBERTS (R&S AND COMPANY) SCHAEFER

the measure of quality is

performance

Moly-Cop Grinding Balls perform superbly on toughest grinding jobs because they have the necessary hardness to stand up to the long economical grind. They wear evenly because of that hardness which is uniform right to the core. That's the result of technological control in alloying, forging and heat treating by Sheffield. And the reason why Moly-Cop Balls are THE STANDARD OF COMPARISON AROUND THE WORLD.

SHEFFIELD

ARMCO®

MOLY-COP

TRADE MARK

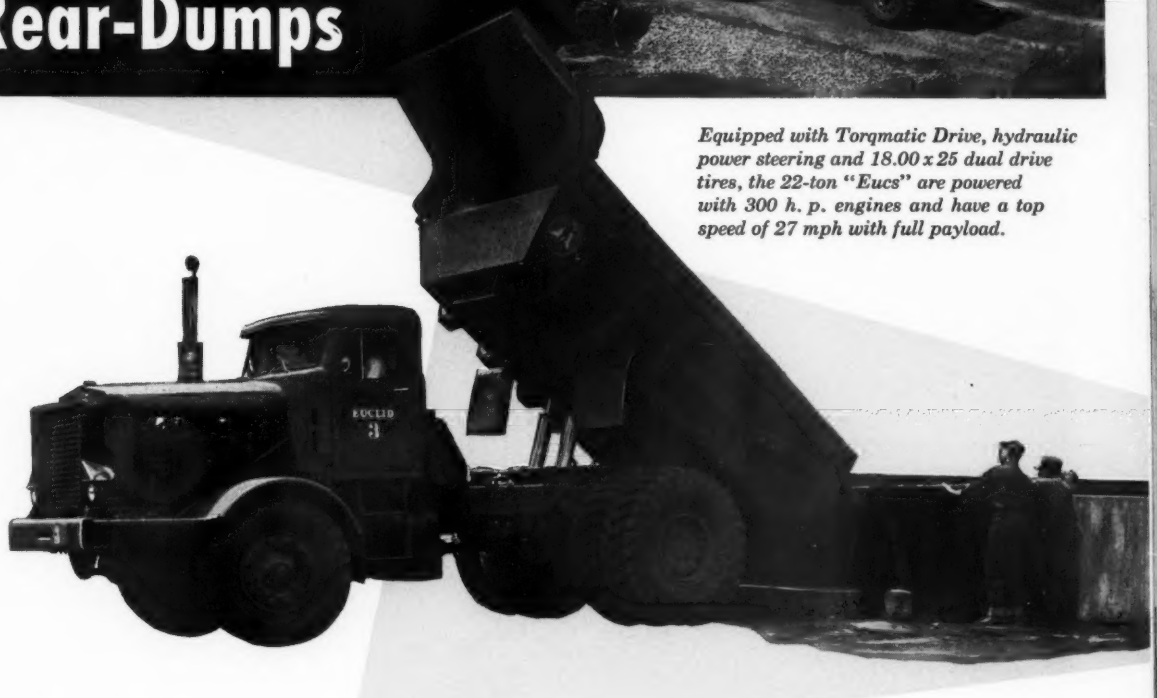
COPPER-MOLYBDENUM-ALLOY

Grinding Balls

SHEFFIELD DIVISION ARMCO STEEL CORPORATION SHEFFIELD PLANTS: HOUSTON • KANSAS CITY • TULSA

EXPORT REPRESENTATIVES, THE ARMCO INTERNATIONAL CORPORATION, MIDDLETOWN, OHIO

87% Availability with "Euc" Rear-Dumps



Equipped with Torqmatic Drive, hydraulic power steering and 18.00 x 25 dual drive tires, the 22-ton "Eucs" are powered with 300 h. p. engines and have a top speed of 27 mph with full payload.

Five Euclids haul 2500 tons of rock daily for Dragon Cement Co.

Steady production is maintained at Dragon Cement Company in Northampton, Pennsylvania with a haulage fleet of six 22-ton Rear-Dump Euclids. Simple, rugged construction and a thorough preventive maintenance program have enabled these reliable haulers to post an 87% availability record. Depending on production requirements, four or five of the "Eucs" work an average of 6 hours per day each, with either one or two held for standby service.

Assistant Plant Manager F. J. Anderson reports that the Euclids are loaded by two 2½ yd. shovels and haul an average of 2500 tons of cement rock daily to the dumping spot over a mile away. Loads are dumped into the 35-ton hopper in 30-45 seconds. Total time for the 2¼ mile trip from loading shovel to hopper and return averages 11 minutes.

The dependable performance of "Eucs"—job-proved on hundreds of mine, quarry and industrial operations—results in more work done at lower cost per ton. Your nearby Euclid dealer will be glad to provide you with facts and figures on the complete line of Euclid earthmoving equipment... and show you why ***Euclids are your best investment.***

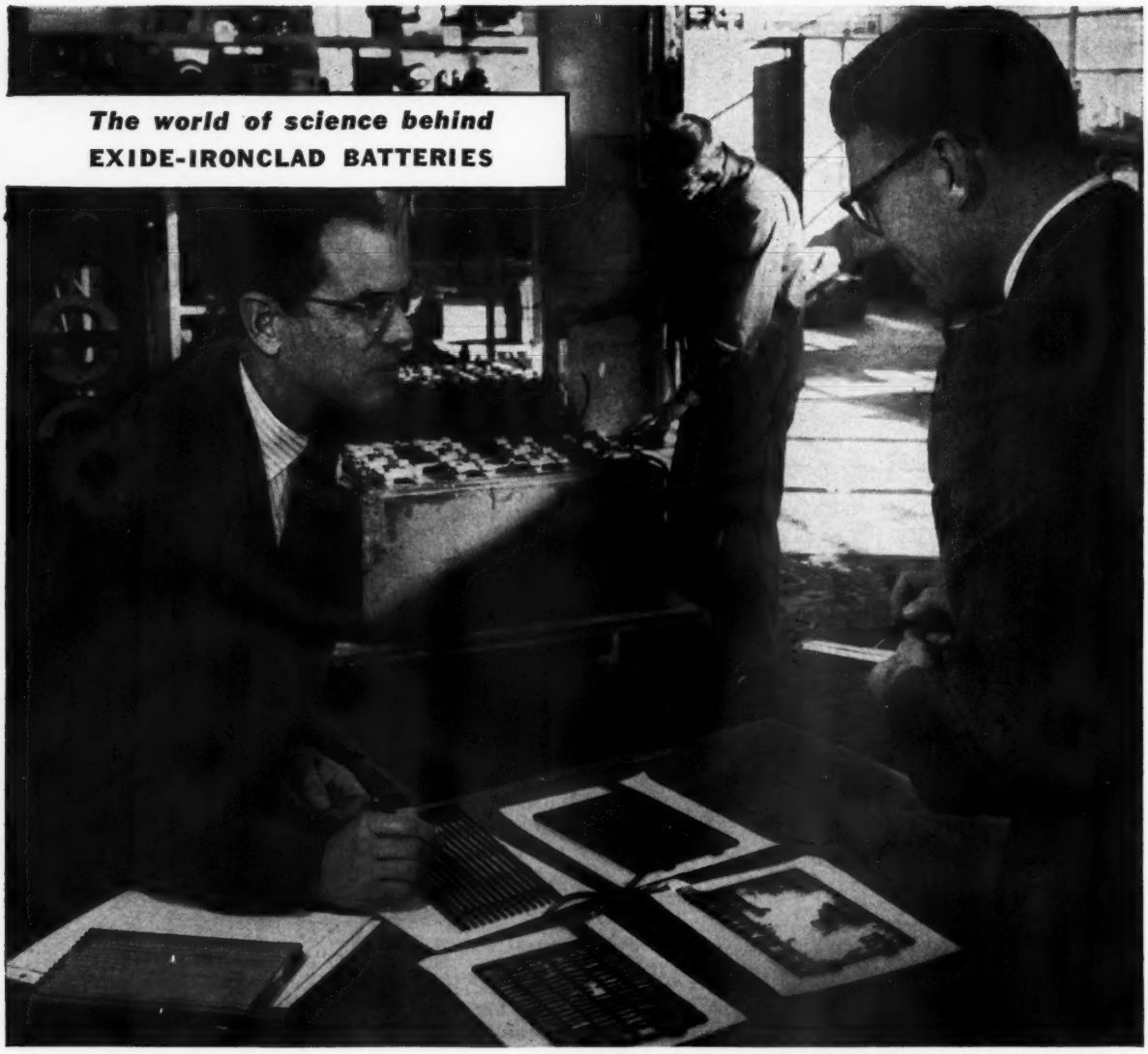
•

EUCLID DIVISION GENERAL MOTORS CORPORATION, Cleveland 17, Ohio

Euclid Equipment

FOR MOVING EARTH, ROCK, COAL AND ORE

The world of science behind
EXIDE-IRONCLAD BATTERIES



Being interviewed is W. W. Smith, Divisional Manager, Product Engineering. Grids in back are of Exide's exclusive Silvium. Those in front are ordinary alloys.

"All of these alloys had the same acid test"

At the Exide Laboratories—**Reporter:** Was it a typical charge-discharge test normally used to test battery components?

Smith: Right. And the two positive plate grids with no visible signs of corrosion are Exide's patented Silvium alloy.

Reporter: How about the others—what alloys are they?

Smith: They're standard alloys used in other well-known makes of batteries. But they don't have Silvium's corrosion-resisting ingredients.

Reporter: Where is Silvium used?

Smith: In the positive plates of all Exide-Ironclad and many other Exide Batteries.

Reporter: How does it affect battery performance?

Smith: Every test we've made proves it stretches battery life because the grid resists corrosion—sometimes up to 100% longer.

Reporter: Obviously this is an important feature of the Exide-Ironclad.

Smith: Yes it is, but it's just one of many engineering details that contribute to its high capacity and long life.

Note to battery users: Whenever you order heavy duty batteries or the equipment that requires them, be sure to specify Exide-Ironclad. For detailed bulletin, write Exide Industrial Division, The Electric Storage Battery Co., Philadelphia 2, Pa.

THE ELECTRIC STORAGE BATTERY COMPANY **Exide**®

You need this hard worker...

JEFFREY

27-Ton, 4-Wheel Locomotive

This work horse gives you plenty of power to pull heavy pay loads with 380 total horsepower available.

Jeffrey 27-ton, 4-wheel locomotives are driven by two motors having sufficient power to slip the wheels. This assures maximum "haul ability" with a rated drawbar pull of 13,500 lbs. at a speed of 10.8 mph.

Outstanding operating and safety features may include: roller-bearing type journal boxes and motor axle suspensions—air and dynamic service brakes—automatic couplers with air-operated uncoupler—trolley with air-operated retriever—separate blower for each motor—32 volt battery-operated control and headlights.

You can depend upon this mine locomotive for day in and day out operation with a minimum of maintenance.

Catalog 836 describes all types of Jeffrey mine locomotives. The Jeffrey Manufacturing Company, 958 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING · PROCESSING · MINING EQUIPMENT... TRANSMISSION MACHINERY... CONTRACT MANUFACTURING

672 holes a day

...two-shift performance of seven RBD-30 Roof Bolting Units at the Island Creek Coal Company

Island Creek Coal Company's #3 Elkhorn Seam in Kentucky averages only 34 inches in height—a real tight squeeze. But not for the CP Roof Bolter! The RBD-30 is only 28 inches high. It moves into low seams, drills at 4 feet per minute, and sets the expansion bolt. On occasion, performance has reached 840 holes a day. Pantograph mounting of drill and bolt-setting motor eliminates need for repositioning. A six-inch auger adjustment on the telescopic chuck overcomes the problem of roof irregularities. Available in self-propelled and standard types—both ideal for low coal conditions. *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, New York.*

Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

HEAVY — RUGGED — POWERFUL

Auger at LOWEST Cost With a McCARTHY Coal Recovery Drill because...

1. **SELF-MOVING in any direction**
2. **2-MAN CREW for all augering**
3. **EASIER MAINTENANCE**

There's more profit in every ton of coal augered by a McCarthy coal recovery drill.

A McCarthy drill requires only two men to operate. It moves itself from hole to hole without the help of any extra men or equipment. It delivers more tonnage per horsepower than any other coal recovery drill.

A McCarthy drill stays on the job, producing more of the low-cost coal that means extra profit for you. Maintenance costs are lower too. McCarthy drills are designed and built by pioneers in coal recovery machines. They are heavy, rugged and powerful.

Write or phone for more information on McCarthy coal recovery drills.

Use McCarthy for More Profit from Every Ton

Manufacturer of Drilling Equipment Since 1901

MANUFACTURED BY

THE SALEM TOOL COMPANY

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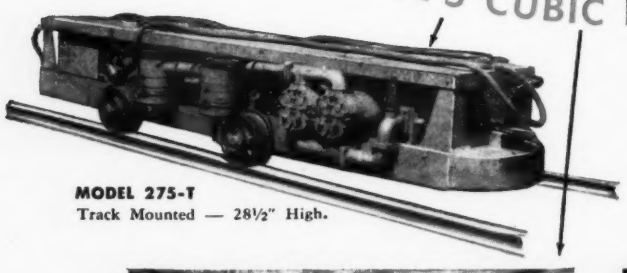
SALEM

ACME MINE COMPRESSORS–

Rugged • Dependable • Maneuverable • Self-Contained

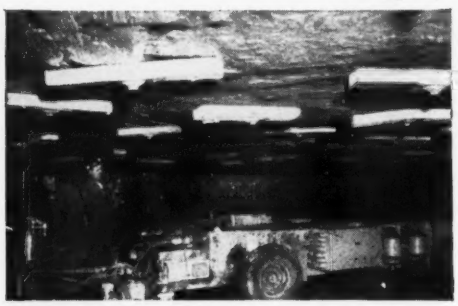
...and VERSATILE

275 CUBIC FEET OF AIR



MODEL 275-T
Track Mounted — 28½" High.

MODEL 275-S
Low Coal Special — 29" overall — Less if it is to be mounted in a carrier.



MODEL 275-SPRHS
Rubber Mounted — Self Propelled. Two stoper Jumbo Arms with stopers and dust collectors — 34½" high with 9" ground clearance.

MODEL 275-TD
Track Mounted — 2 Drifter Jumbo Arms and Heavy Duty Drills for Rock Work. Arms may be interchanged with stoper Jumbo Arms.

One of these machines will fit YOUR mine conditions.
Variations such as with or without cable reels, variable ground clearance, seats, etc. are available. Full hydraulic drive and steering. Parking and tramming brakes.

Write or call us and let us quote on your requirements —
We will be glad to demonstrate in YOUR mine.

ACME MACHINERY COMPANY

ACME MACHINERY COMPANY

WILLIAMSON, WEST VIRGINIA

WAREHOUSE AND SALES OFFICE
MORGANTOWN, W. VA.

REPRESENTATIVES IN PRINCIPAL MINING AREAS

It's the "give" in the Yieldable Arch that does it

Where conditions underground are unstable, no rigid type of roof support however strong, can long withstand these dynamic forces. Often, the more rigid the support, the more it may aggravate the situation.

Bethlehem Yieldable Arch utilizes the old technique of letting the enemy beat himself. By gradually yielding, or "giving," under the excessive pressures, the Arch gives the overburden a chance to settle into a natural arch of its own, and thus bring forces into equilibrium. As long as the pressures are excessive, the Arch will continue to "give"; as soon as stability is reached, the Arch holds the line.

A set of Yieldable Arches consists of curved U-shaped sections nested together and overlapped enough to permit clamping with husky U-bolt clamps. The clamps control the degree of tightness of the joint, and permit yielding when the forces exceed the load for which the joint was intended. Each Arch set is tied to adjoining sets by means of horizontal struts, which add lateral rigidity to the structure.

Besides increasing mine safety, the Yieldable Arch offers high salvageability, and usually pays for itself within its first year of service. A Bethlehem engineer would like to discuss the Yieldable Arch with you —in terms of your own roof problems. You can reach him through the nearest Bethlehem Sales Office.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

KEEP PRODUCTION ROLLING *with help like this . . .*

- **EXCLUSIVE "ROLL-AWAY" MOLDBOARD . . . moves tough dirt fast**
- **NEW TOGGLE-TYPE CONTROL . . . kick-free in the rough . . . pinpoint accuracy**
- **HIGHEST AXLE AND THROAT CLEARANCE in its class . . . for better handling of biggest loads**
- **TOUGH TUBULAR FRAME . . . shock-absorbing strength down the middle**
- **BOX-SEAT COMFORT AND VISIBILITY . . . satisfied operators . . . more and better work done on all grading jobs**

ROLL-AWAY is an Allis-Chalmers trademark

These are five of many reasons why Allis-Chalmers FORTY FIVE motor graders are showing up in more and more mining and quarrying operations. They are precisely what the dirt-moving specialists ordered . . . ready now to handle haul road construction and maintenance easily, smoothly. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS *Engineering in Action*

GENERAL CABLE!

SUPER SERVICE

PORTABLE POWER and MINING CABLE

5 KV *Super Service* Type SH-D cable at work on the $50,000,000 Great Salt Lake fill project. Morrison-Knudsen Company selected *Super Service* as the most dependable, long-lived shovel power cable for hard service in rugged terrain.

UNBEATABLE PERFORMANCE

under toughest service conditions

Exclusive construction features give General Cable's *Super Service* portable power cable superior durability and long life under the most severe conditions. *Supertuf* mold-vulcanized neoprene sheath has unequalled resistance to wear, cutting and other mechanical abuse. Double-layer cord reinforcement adds extra strength. Sheath has outstanding resistance to water, oil, acids, alkalis, flame, sunlight and weathering. Available in a *complete* line from 600 V to 15 KV.

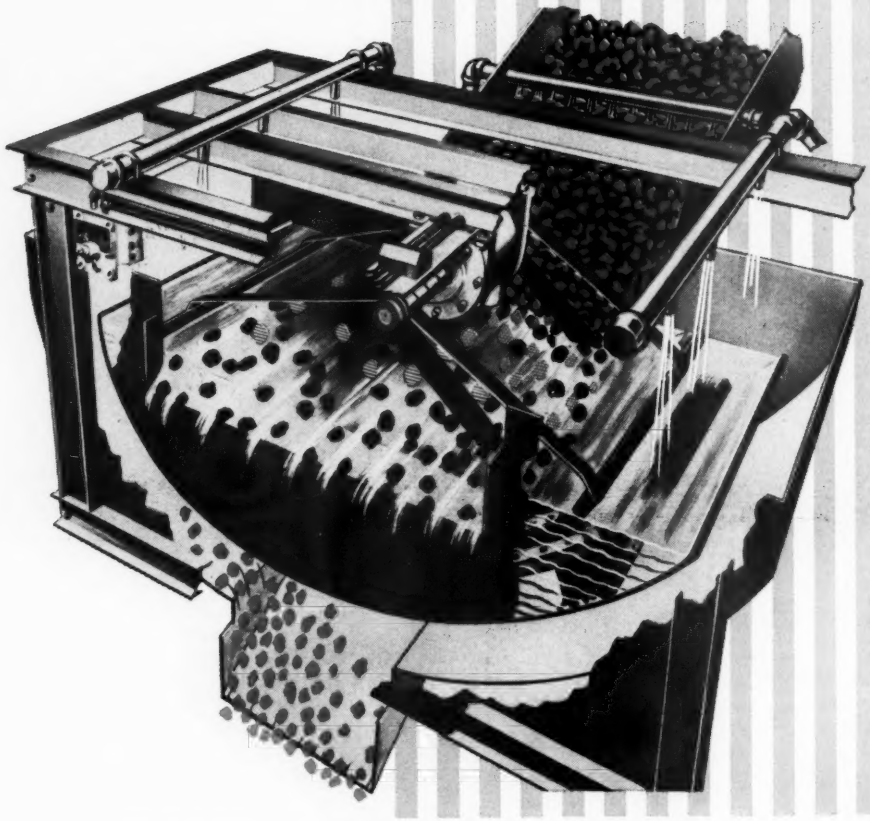
GENERAL CABLE CORPORATION, 420 Lexington Avenue, New York 17, N.Y.
Offices and Distributing Centers Coast-to-Coast

for quality and service... **specify GENERAL CABLE**

WILMOT'S

HEAVY - MEDIA SEPARATION

VESSELS . . . . .



. . . CUT PRODUCTION COSTS

by offering operating simplicity and minimum maintenance requirements throughout your entire processing schedule.

Available in several sizes Wilmot-OCC H-M Vessels accommodate individual installation requirements either as replacement units or as parts of newly designed Heavy Media Systems.

For complete information send for bulletins giving general descriptive information of all Wilmot Coal Preparation Equipment.

WILMOT ENGINEERING CO.

HUNTINGTON, W. VA.: PO Box 1831, Phone JAckson 5 2571

WHITE HAVEN, PA. *Exec. Offices* HAZLETON, PA.

W WILMOT

Stockbridge replaces 8 trucks with 4 Macks

"We recently put four large-capacity Mack dumpers to work on a job that had required the full-time efforts of eight smaller trucks of competitive make. First result—four fewer drivers. Then—because of their capacity and agility—these big Mack LRVSW's spent less time spotting under the shovels and dumping at the crusher. Also, we have far fewer maintenance problems because Macks stand up better under the harsh working conditions," says Mr. Ray Lambert, vice president in charge of the Stockbridge Stone Company's Georgia operation.

"We are using 4½-yard electric shovels, and six to seven passes make an average load of about 34 tons. Our Macks easily shoulder these big payloads up the 12% grade from the quarry to the crusher, with the torque converter eliminating much of the shifting and absorbing most of the shock on the drive line. And with Mack's Balanced Bogie with Power Divider, our drivers have no worries about getting bogged down.

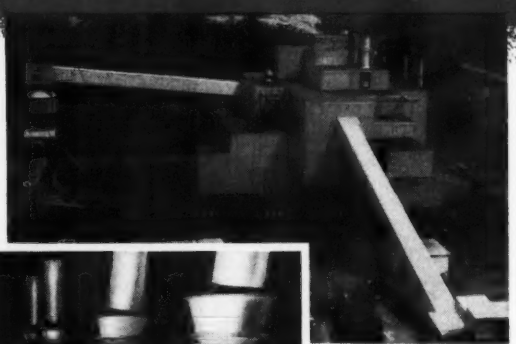
"To sum up our experience with Macks, we've found that you can't beat 'em for profit-making quality!"

Macks help to make a more profitable operation for Stockbridge. They will for you, too, whether your operation is quarrying or mining. Your nearest Mack representative will be glad to illustrate with on-the-job reports that prove the performance and durability of Macks. Mack Trucks, Inc., Plainfield, New Jersey. In Canada: Mack Trucks of Canada, Ltd.

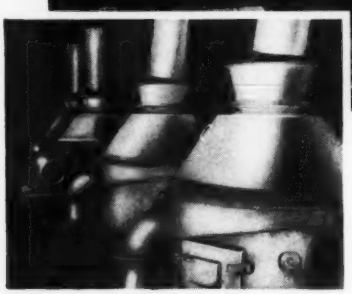
MACK
first name for
TRUCKS

At Moss Mine #2
and again at Moss Mine #3...

CLINCHFIELD COAL PREFERS REINEVELD FINE COAL DRYERS



View of Coal Preparation Plant at Moss Mine #2



Battery of Four Reineveld Fine Coal Dryers at Moss Mine #2

The performance of the four Reineveld Fine Coal Dryers at Moss Mine №2 earned them a place in the new Preparation Plant now being built for Moss Mine №3 where twelve Reinevelds will be installed. Also, eight H & P 24" Raw Coal Cyclones were selected for Moss Mine №3.

From mine portal to market, Heyl & Patterson has served the Coal Industry since 1887 with . . .

Complete Coal Preparation Plants
Bradford Coal Breakers
Reineveld Fine Coal Dryers
H & P Wet Cyclones
Thermal Dryers: Fluid Bed and Pallet
Thorsten Samplers and Crushers
Rotary Car Dumpers
Boat & Barge Loaders and Unloaders
Specialized Conveying Systems

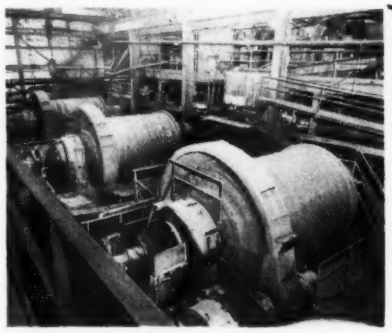
70 YEARS OF SERVICE

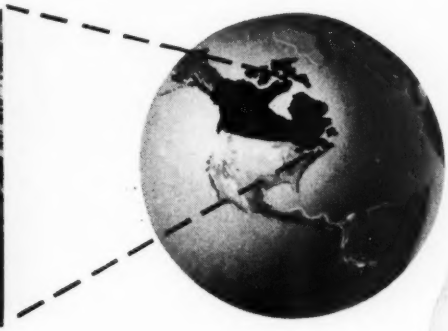
Heyl & Patterson INC.

55 FORT PITT BLVD. • PITTSBURGH 22, PA.

I saw them in Canada, too!

YES, WHEREVER THERE'S MINING, you'll find the successful companies using *Marcy Mills.* The fact that these companies throughout the world continue *reordering* Marcys is evidence of Marcy's low-cost-per-ton production and dependable mechanical operation.





The Quemont Mining Corporation, Noranda, Quebec, has a 9′ x 12′ Marcy Rod Mill and five 9′ x 12′ Marcy Ball Mills in its copper-zinc-gold mill. These mills were sold, manufactured and serviced by Mine & Smelter's licensed manufacturer and sales representative, Canadian Vickers, Ltd., Montreal. The Quemont mills are just six of more than 150 Marcys in Canada

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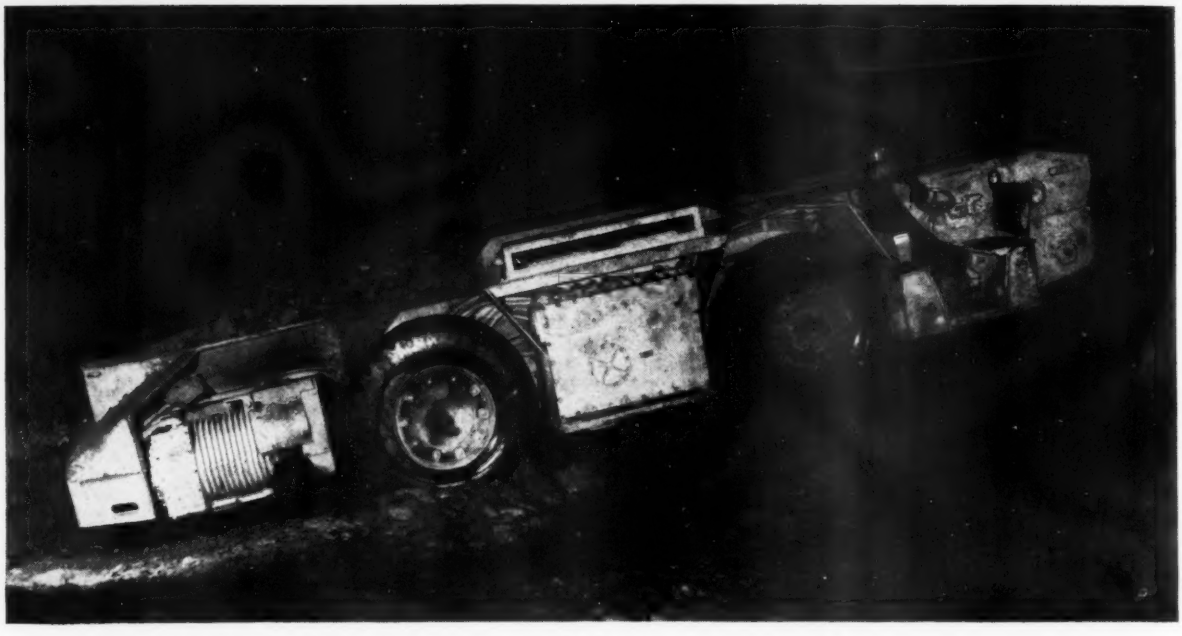

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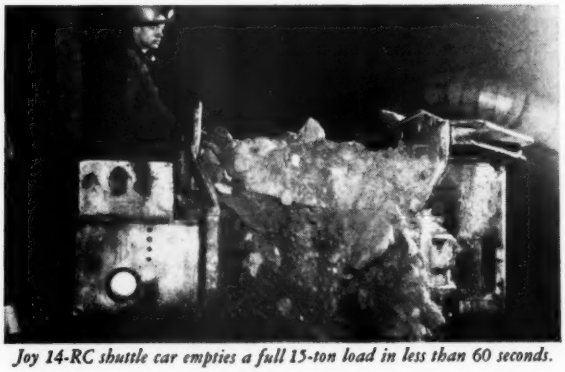

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EDITORIALS

ROBERT W. VAN EVERA, Editor

DECEMBER, 1957

STOCKPILES AND SPUTNIKS

[The following editorial, reprinted from *American Metal Market*, November 20, 1957, speaks for itself.]

Beset as the country is with a multiplicity of grave problems, the solution of which will tax severely our ingenuity and our intelligence (not to mention our capacity for "taking it"), it is the height of foolishness needlessly to stir up others which, in this emergency, should be ignored. Such is the talk going the rounds concerning the strategic stockpiles, and the possibility that substantial parts of them will be unloaded on markets at a time when the materials are already in surplus supply.

These stockpiles are enormous, embrace 70 or more different classifications of materials, and are estimated to represent an investment of over $5 billions. The national need for substantial reserves of critical, strategic materials was amply demonstrated during World War II and again at the time of the Korean crisis. . . .

Even before the sputniks soared above the horizon, there was a lot of loose talk about liquidating portions of the stockpile in order to free the government of carrying charges, reimburse the Treasury in part for its vast outlays, and so contribute to the balancing of the budget and adherence to the statutory debt limit. These suggestions were reminiscent of the trading novice who gets over-extended during a boom and, when pressed for more security by his creditors, sells on an unreceptive market, at a substantial loss. The Government has always been a long way from having to resort to this ridiculous procedure, which presently could only make economic matters worse by calling upon the economy to absorb reserve stocks at a time of market weakness brought about in part by an oversupply of materials. Admittedly, however, the outlook toward the stockpile has been materially modified by the appearance of the sputniks.

Their introduction ominously forecasts a time when the possibility of attack by ballistic missiles must be regarded as a distinct probability. Whether launched against us from the decks of large numbers of surfaced submarines, or from overseas bases, the onslaught would give but little warning, and the possible devastation from nuclear war-heads could be on an unprecedented scale. It is, therefore, no more than good sense to study the potential need for stockpiles of finished goods, including medical supplies and foodstuffs, which would be immediately available. In both previous world conflicts, we had many months for preparations before we became involved in the conflicts, and in neither was our mainland under attack. Before sputnik, it was confidently expected that we would have at least a number of hours' warning, against approaching bombers, to be utilized not only in gaining shelter but in launching defensive and counter-offensive operations which might be expected greatly to reduce the number of hostile bombers arriving over our cities. We can no longer count on this margin of grace, making stockpiles of materials which would have to be processed before they could be utilized useless in furnishing relief and sustenance in the first hours—or days—of hostilities.

Granting, therefore, the need for a supplementary or more varied stockpile of emergency supplies, it does not follow that what has been accumulated has become suddenly obsolete and deserving only of premature liquidation. The commodities that are already in the stockpile are basic materials, for which there could be certain use, in time, in the event of hostilities of any type. Even if they were not, however, it would serve no useful purpose to force their liquidation, and no good can be accomplished by "rumoring" that such plans are being contemplated.

It does not require a long memory to recall the unsuccessful efforts that were made to obtain the release of stockpiled copper, when there was an acute shortage and the metal was quoted as high as 55 cents a pound in the open market. Despite the present situation in copper, it is not impossible that, in an emergency or another boom cycle, a parallel situation could again develop. That will be time enough to talk about releasing stores that were accumulated, under the law, with the understanding that they would not be thrown on the markets but held strictly for the purpose for which they were acquired. It would be helpful to all concerned if talk about premature disposition were to cease and confidence restored in the continuing permanence of the reserves which have been acquired.

FREEDOM OF LABOR

We have long supported the individual's right to work, without regard to whether he belongs or does not belong to any particular organization. The "right to work" has today become a very controversial subject. Yet back in 1932 the Norris-LaGuardia Act—which was hailed by labor as its "charter of freedom"—declared the public policy of the United States to be protection of the individual's "freedom of labor."

Without discussing the anti-injunction feature of that Act, let's re-examine the public policy as set forth by Congress in the "charter of freedom," which was so enthusiastically acclaimed by labor twenty-five years ago. Specifically, the Act declared that the individual worker should have "full freedom of association, self-organization, and designation of representatives of his own choosing to negotiate the terms and conditions of his employment . . ." and *also* that he "should be free to decline associate with his fellows."

What does this mean if not the right to work? Isn't it time to get back to first principles?

With the general trend towards a larger haul unit, the past 15 years have seen improvements in almost all parts of the off-highway truck

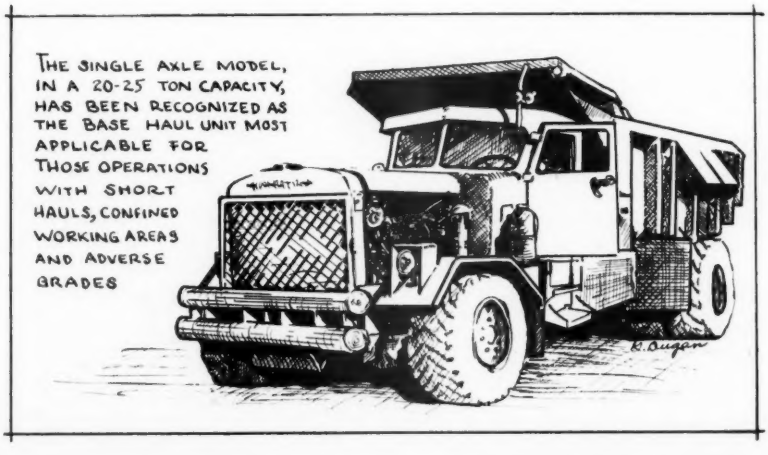
advances in off-highway truck design

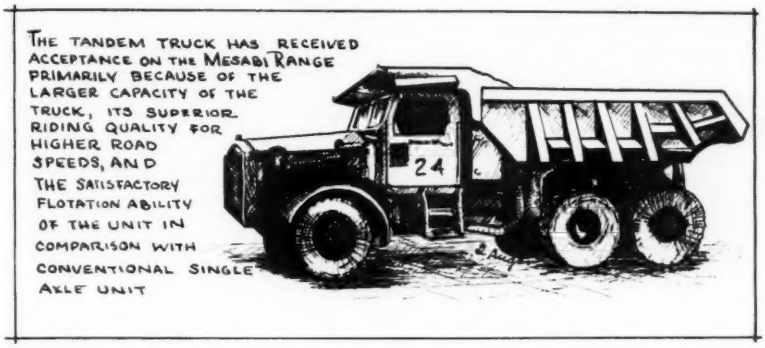
By GORDON N. CARLSON
District Mechanical Engineer
Pickands Mather & Co.

DURING the late 1930's the open pit mining operations on the Mesabi Range recognized the need for additional means of material conveyance other than by conventional rail haul. As mining operations were developed to greater depths in limited areas, and disposal areas became critical, it was evident that rail haul would have to be abandoned, in many cases, in favor of mobile haulage equipment. In 1937 truck haulage had its inception by the introduction of the 15-ton, single axle truck. The modern off-highway truck is a far cry from the first 15-ton unit, the evolution of which is a result of the combined efforts of the mine operators and manufacturers to design a larger and better haulage truck. This report will encompass: first, the advances which have been made in the off-highway truck relative to capacity and type; second, the factors promoting design advances; and last, the current status of development of truck components.

Haulage Truck Capacity and Type

Since 1937 our industry has observed many advances relative to the capacity and style of truck. The first major change in the single axle truck was made in 1944 with the introduction of the 20 ton capacity truck, with 16:00 by 24 in. tires on the drive wheels and powered with a 200-hp supercharged engine. The inadequacies of this first larger unit in both horsepower and tire capacity resulted in the 1945 model, 22-ton truck with 18:00 by 24 in. tires on the drive axle and powered with a 275 hp supercharged Deisel engine. With this truck, rapid design improvements developed in the expendible components, including the development of the torque converter.





20-25 Ton Capacity, Single Axle Trucks. The single axle model, in a 20 to 25-ton capacity, has been recognized by Pickands Mather & Co. as the base haul unit most applicable for those operations with short hauls, confined working areas, and adverse grades. Further, it has been recognized as the most versatile unit, since it can be utilized for flexible operational requirements. Because of its limited hauling capacity and the ever increasing need to reduce production costs, current field tests are being conducted to promote improved truck performance on the grade with larger prime movers and corresponding converter-transmission packages.

30-40 Ton Capacity Tandem Trucks. Because of the need for larger capacity trucks on long hauls, and where "flotation" was recognized as a limitation in the single axle truck, the Mesabi Range saw the first 30-ton tandem units in the early 1940's. This original unit, powered with a 200-hp engine, was very slow and not desirable. In general, the late 1940's and early 1950's saw the advent of the tandem style truck in the 30 and 34-ton capacity. These units have advanced considerably in design since their inception and are available to the operator today in several competive lines.

In all probability the 40-ton capacity tandem truck is the latest design thinking in tandem trucks to be introduced to the operator. As haulage distances have increased and a higher road speed became desirable, the inadequacy of the tire capacity of the conventional 34-ton truck has become a very important factor. Where these trucks are equipped with 16:00 by 25 in. tires on the drive axles, it has been determined that the tires are subjected to an appreciable overload. Where this overload is coupled with higher road speeds on long hauls, extreme heat and resultant separation caused by carcass flexing has been encountered. Because of the abnormally high tire maintenance resulting from this type of operation, one of the equipment manufacturers is now presenting a 40-ton truck with 18:00 by 25 in. tires, front and rear, to reduce the overload on the tires. Where higher road speeds are desirable for long hauls, the 40-ton chassis can be fitted with a 34-ton capacity dump body to reduce the tire overload. Where maximum road speed is not a critical factor, but where maximum capacity and/or flotation of the tandem is most desirable, the standard 40-ton truck can be utilized.

The tandem truck has received acceptance on the Range primarily because of the larger capacity of the truck, its superior riding quality for higher road speeds, and the satisfactory flotation ability of the unit in comparison with the present single axle unit. Our company has not accepted this truck as being a universal haulage unit because of its limitations in smaller confined operations.

30-35 Ton Capacity, Single Axle Trucks. Recognizing the need for a universal haul unit, with capacities in excess of the present single axle truck, the operators are now being introduced to several lines of single axle, 30 to 35-ton trucks. This is the newest line to be presented in the off-highway truck design to the Mesabi Range and is still in its infancy. With the advent of larger engines and converter transmission packages, the increased road speed coupled with the maneuverability of the shorter wheel base, the single axle truck may prove to be feasible where excessive flotation is not an operating requirement.

At the present time field tests are being conducted by P. M. & Co. on a 35-ton, single axle truck powered with a 400-hp, V-12 Diesel engine and equipped with 18:00 by 33 in. tires on the drive axle and 18:00 by 25 in. on the front axle. This truck is equipped with a three-stage torque converter capable of absorbing and transmitting the 400 hp, with the additional features of downhill braking and converter lock-out. Mounted mid-ship to the converter is a three-speed mechanical transmission theoretically rated for horsepowers up to 600 and is another first for the industry. Data compiled on this unit is very limited at this time, and definite conclusions can not be made. The company has noted, however, an indication that satisfactory road performance, both on the grade and level, acceptable ease of handling, and maneuverability in confined working areas are evident.

Factors Promoting Advances in Design

There are several factors which have promoted advance designs in the off-highway truck for the Mesabi Range.

Range Mechanical Committee. One of the most important factors contributing to the promotion and acceleration of design advances has been the results of the combined efforts of mine operators in the Range Mechanical Committee. The general purpose of this committee, organized in October 1951 with a nucleus of 16 men representing ten mining companies, is to improve the design of equipment and to let the manufacturers know just what is required in heavy duty equipment for the Mesabi Range mining operations. The specific purposes of the organization are to discuss the mechanical problems first and the mechanical problems relative to production problems second. Membership of the committee is limited to mining organizations with ten or more units, allowing one representative for each 50 units, and does not include equipment manufacturers, their representatives or salesmen.

Originally the committee's function was a clearing house for exchanging ideas which led to accumulating data on various equipment components to give a combined average experience across the Mesabi Range. Special committees, appointed by the chairman, were delegated the responsibility of compiling the data, as it was submitted by the various operators, and tabulating this data in composite surveys. From this information items of questionable design were sent to the equipment manufacturers, and special meetings to discuss these mutual problems resulted. This was the beginning of a series of such meetings which has resulted in mutual benefits for both the operator and manufacturer. Progress reports are submitted to the committee for the purpose of keeping the operator abreast of the design changes resulting from these special meetings and committee evaluation of same. The committee also functions to expedite design changes.

The results of the organized efforts on the part of the operators participating in this committee may be resolved into two parts which affect truck design. The first would be the establishment of specifications for haulage trucks and their components for application on the Range. The heated dump body construction, incorporating one-in. mild alloy bottom liners and ship channel sub-flooring, and versions thereof, depending on operating conditions, is a major contribution of committee effort. A standardization program for the basic purpose of establishing standards,

largely for safety and efficiency reasons, resulted in a special meeting with four leading truck manufacturers and two cab manufacturers in 1953. As a result of this meeting, the current heavy duty mining cab with all of its special features materialized. Included in this model are the specifications on cab construction and size, insulation, ventilation, cab fittings, standardized instrumentation, type of operating controls and location, and many additional features in truck designs promoting safety and efficiency in operation. These are but a few examples of specifications which have materialized as a result of the combined committee and manufacturers' efforts since 1951.

The second important effect that the "R.M.C." has had on advances is the campaign to design for extended life of truck components to reduce truck maintenance. Special meetings with the equipment manufacturers to discuss items of questionable design have resulted in the use of better materials, improved quality control in manufacturing procedures, design changes with emphasis on interchangeability and standardization, all to extend average component life.

The unified efforts of the operators have resulted in accelerated retooling programs by most of the equipment manufacturers to produce a better haul unit for operations on the Range.

New Equipment Entries. Another important factor promoting advance design in the off-highway truck has been the introduction of additional entries in the field. In the early stages of truck haul on the Mesabi Range, advances in design resulted from the concentrated efforts of three leading truck manufacturers and the mine operator. The picture for 1958 indicates that there will be at least eight manufacturers offering 11 different capacities in a single axle truck and four payload capacities in a tandem style, with a wide variety of power train packages available.

One of the new entries to be presented in 1958 introduces a new concept in truck design, embodying design features which will certainly be worthy of attention. This truck will be a 30-ton, single axle unit powered with a 375-hp, V-8 Diesel engine. Emphasis has been placed on a low center of gravity with adequate ground clearance, minimum turning radius for maximum maneuverability, and reduction of weight. A unique frame design and the replacement of the conventional spring suspension and cross axles with four hydraulic-pneumatic cylinders, one for each wheel providing independent wheel suspension with a controlled variable spring rate, are the main contributing factors permitting this design. A new dump body construction, with low loading height and low center of gravity, and multiple disc air brakes coupled with an "eddy current" retarder are additional design introductions to the industry.

Competition is very desirable from the operator's viewpoint and should result in some very interesting design changes in the near future.

Field Test Programs. Extensive use of experimental units has enabled both the operator and manufacturer to determine the type and size of truck most applicable for the job requirements and, further, has been very instrumental in the development of new models and designs. The general trend, since 1937, has been towards a larger haul unit, both in a single axle and double axle type, the progress of which has been impaired by the inadequacies of the truck components, lack of compatibility with operating equipment and conditions, and the process of time consuming field test programs.

Advances in Truck Components

Where necessity is the mother of invention, the past 15 years have seen vast strides made in the design improvements of almost all parts of the off-highway truck. In this report emphasis will be given to the prime mover, converter-transmission packages, and the tire picture today.

Diesel Prime Mover. The general trend in the Diesel engine, two cycle and four cycle, has been towards a higher horsepower capacity correlated with higher speeds designed with reduced weight per horsepower and compactness. Simplicity of design for maintenance purposes, and better material and workmanship have been the keynote in this evolution. By making various changes in the internal parts of the naturally aspirated, 200-hp, 4-cycle Diesel engine, increased output has been accomplished by means of supercharging, and more recently by turbocharging, for a total increase of 135 hp. Geared to the higher output of the engine has been an increase in governed speed from 1800 rpm to 2100 and 2200 rpm, and the most recent introduction of 2300 rpm engines. Where torque is the governing factor in the selection of drive sizes, the trend towards higher rotative speeds resulting in a lower torque for maximum horsepower should promote lighter and less expensive converter-transmission packages.

Where the original 15-ton truck was powered with a 150-hp engine, the modern 35-ton capacity truck is equipped with a V-12, 400-hp high speed Diesel engine. The original pacemaker in the mining field was the 4-cycle, 150 hp at 1800 rpm, a naturally aspirated engine with a weight of 15.7 lb/hp. This was a slow speed engine with a long stroke, and supercharging to 200 hp was not adequate. With the 22-ton truck we were introduced to the supercharged 300 hp at 2100 rpm 4-cycle Diesel engine at 8.9 lb/hp. This model has been subjected to many changes since 1944, the most recent of which has been the turbocharged version developing 335 hp at 2100 rpm with a weight of 7.4 lb/hp.

The two main factors contributing to improvements in the Diesel engine over the years have been:

1. Those problems resulting from the increased horsepower by supercharging and, more recently, turbocharging, and the increased speed.
2. The constant demand by the operator for extended engine life.

Better materials have been developed for blocks, heads, valves, rocker levers, crankshafts, etc. to take care of the greater horsepower. The copper lead strip bearings were incorporated for the horsepower requirements, simplicity and economy. Balance requirements and engine tolerances are more critical to overcome those problems encountered with higher speeds.

Field tests are now being conducted on a 375 hp at 2300 rpm, 4-cycle turbocharged engine with a weight of 6.7 lb/hp. This may be the immediate answer to increased horsepower engines in the 20-25 ton haul unit.

The future picture for engines in this class of truck may be indicated by the release of the first V-8 engine this fall for field testing. This engine will develop 375 hp at 2500 rpm with a weight of 7.6 lb/hp. Design advantages of the V-8 model are primarily the reduction of weight per horsepower, a shorter engine length allowing more of the truck length to be devoted to body and payload, instead of to engine compartment, and accessibility of engine accessories on the top of the engine in the V.

The six in line, two-cycle engine was first used as the twin prime movers in the experimental 24-ton tandem truck in 1947 at 190 hp each. The current version of this model is now turbocharged to 235 hp at 2100 rpm and applicable in the new 40-ton tandem truck with twin engines. The two-cycle, six in line engine is also available with a rating of 300 hp at 2000 rpm for use in the 20 to 25-ton capacity truck.

For the larger haul units, 30 to 40-ton capacity, with single prime movers, the 4-cycle, V-12 Diesel engine rated for 400 hp at 2100 rpm has been in the field since 1950. This engine is naturally aspirated, and when turbocharged can deliver upwards to 600 hp at 2100 rpm. Where horsepower requirements in excess of 400 are evident, they will not be utilized until such time as the converter-transmission packages are available.

Probably the most important design innovation in the Diesel prime mover for haul trucks has been the advent of the turbocharger, which is still in its infancy. While the turbocharger has long been recognized for application with constant speed stationary

This 64-ton semi-trailer dump truck—one of the largest rear dump semi's ever built—is powered by a 400-hp, 12-cylinder diesel engine. Five of these trucks were recently placed in operation at Kaiser Steel's Eagle Mountain iron ore mine in southern California

engines, and where low speed performance is not critical, its poor response to load change, high costs, and limitations on exhaust gas temperatures have retarded its promotion for haul trucks. Recent simplified design, better materials, new light weight low inertia turbine and compressor wheels have reduced some of the limitations for automotive application. Turbocharging has increased the output of the Diesel engine and reduced specific fuel consumption in two ways:

1. In the four-cycle engine the parasitic load of the mechanical supercharger has been removed and, in the two-cycle engine, resultant reduced blower loads have been accomplished with a slower speed of the blower.

2. Improved combustion resulting from the increased air in the cylinder per pound of fuel or higher air-fuel ratio.

Two major things have resulted from field tests with turbocharged engines which are:

1. The limitation of the turbocharger to respond to changing load has been the most troublesome factor. Field tests are now being conducted on a throttling control, actuated by the intake manifold pressure, which regulates the fuel supply during acceleration to reduce objectionable exhaust smoke. The reduced horsepower available for acceleration may prove to be a limiting factor in some applications.

2. The accelerated wear on the engine resulting from the increased volume of air and proportional entrapped dirt to the cylinders. This problem has instigated a major program by one engine manufacturer to "dustproof" the engine against external contamination by pressurizing the crankcase, testing for a more efficient air cleaner, and developing better intake piping and fittings.

Torque Converters and Transmissions. Development of the converter-transmission packages has been a costly program to the operators, and one of the major factors retarding the evolution of truck size. Where the 400-hp engine has been in the picture since 1950, it was not until recently that a converter was released for field testing with this engine. We have been fortunate in that one leading truck manufacturer has had a mechanical transmission capable of transmitting the torque requirements of the 30 and 34-ton truck, which has enabled us to utilize this 400-hp engine.

In regard to the converter and semi-automatic transmission package, several advance designs are in the offering. This application, at the present, is not available in the 375 to 400-hp class. In 1956 the Mesabi Range saw the latest design thinking in this package in a semi-automatic, four-speed transmission, with a built-in single stage converter and a converter lockout feature. With this model the first attempts were made to incorporate a power takeoff which would eliminate continuous operation of the hoist pump. The forward picture indicates that this series in horsepower ranges of 375 to 400 will be available this fall for field testing with the converter lockout and downhill braking.

The second type that we are familiar with is the three-stage torque converter rated upwards to 500 hp, with a mechanical transmission with converter lockout and hydrodynamic braking. Depending on the application, there are two different models offered today. One model is available where job requirements consist of long hauls over variable grades where there is a need for converter operation on the grade and efficiencies of the mechanical transmission on uniform long hauls. In this model, converter operation, downhill braking,

(Continued on page 57)

Design of a Power Installation For a Continuous Operation

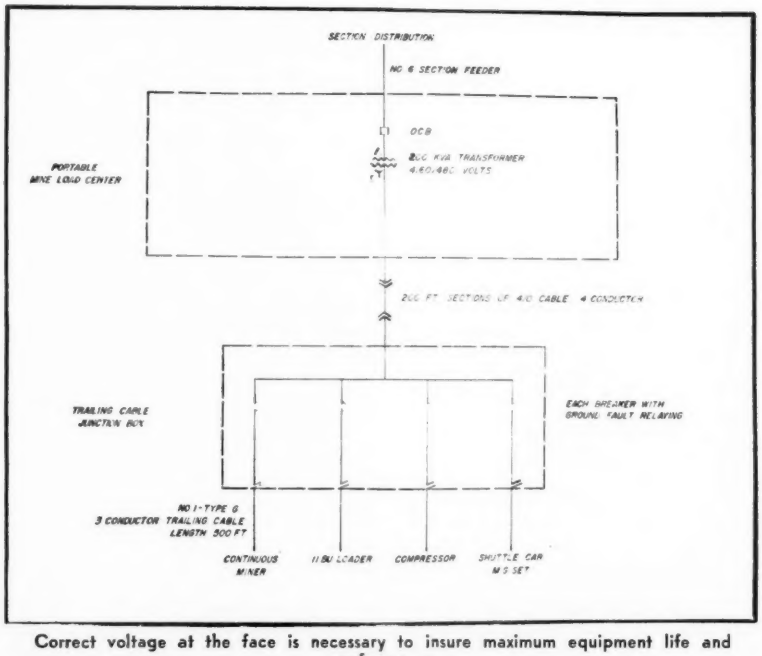
This report on the power distribution system in use at three coal mines of Kaiser Steel Corp. is of particular interest because: (1) the company has nine continuous mining machines in operation and (2) it has now standardized on a-c equipment underground

By W. C. WRIGHT
Superintendent of Maintenance
Kaiser Steel Corp.

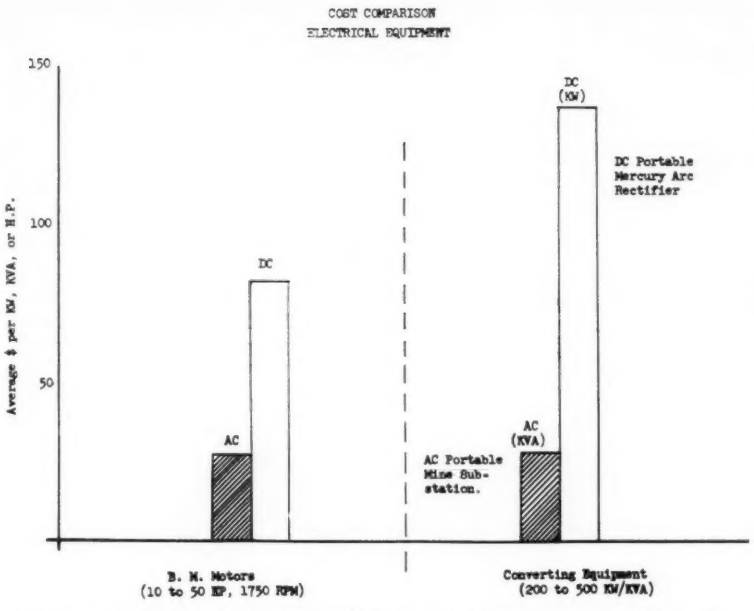
AT the present time Kaiser Steel Corp. has three mines located at Sunnyside, Utah, with total production averaging in the neighborhood of 7500 tons per day. Ten conventional and nine continuous miner units are employed to produce this tonnage. Since this article is primarily concerned with continuous mining, only the power distribution system affecting those sections will be considered. In order to better explain the power setup as used in this operation, let us start at the 44,000-volt source, supplied by Utah Power and Light Co., and progress underground.

Outside Distribution

The incoming power is supplied at 44kv and is first introduced into a central metering station. From this metering station the power is distributed, maintaining the high voltage, to three substations, one for each mine. Each substation transforms the voltage from 44,000 to 4160 volts, the primary distribution voltage for the mines. The total transformer capacity of the three mines is 9350 kva. The No. 1 mine has a rated capacity of 3000 kva, No. 2 mine, 1600 kva and No. 3 mine, 4750 kva. The substation for the No. 3



Correct voltage at the face is necessary to insure maximum equipment life and performance



The experience gained while operating both a-c and d-c continuous miners indicated that the a-c system afforded the most economical and productive operation for this property

mine also supplies power to the townsite and preparation plant. General protective equipment for each substation consists of lightning arresters, air-break and fuse disconnect switches on the 44-kv line and automatic reclosing oil circuit breakers and lightning arresters on the mine feeder lines. The newer installations incorporate tap changing under load or induction type voltage regulation equipment on the mine feeders.

Because the majority of the continuous miners at the Sunnyside operations are being used in the No. 1 mine, this mine will be used as an example of the power arrangement. The substation has a common 44-kv bus and a common 4160-volt bus for the three banks of transformers. Each of the transformer banks has fuse protection and isolation disconnect switches. This arrangement provides adequate flexibility for connecting a continuous power supply to the 4160-volt bus under emergency conditions. There are four feeders taking off from this bus, each protected by either fuses or oil circuit breakers. Two of these feed the mine ventilating system and the substation lighting. The other two are underground lines supplying power to the mine and the mine hoist.

Underground

The 4160 voltage is transmitted into the mine through 4/0 rubber-covered primary cable. One 1500-ft cable supplies power to the main hoist and a separate cable supplies the working sections of the mine. This latter installation follows the intake air from the surface to the bottom of the slopes, a distance of about 6500 ft.

When the power system was originally laid out in about 1944, armored primary cable was used. No. 8 cable was used in the entries due to different methods of mining and reduced power requirements. A large number of failures were experienced with this cable. Since the introduction of the rubber-covered primary cable six years ago, there have been no power outages due to primary cable failure.

Section power is obtained by tapping the 4/0 source at each working level with a No. 6 rubber-covered cable. This No. 6 line extends from the main slope to the 200-kva, 4160-480 volt mine load center substation near the working face, normally a distance of from 5000 to 7000 ft. In the few instances where more than one mining unit is to operate from this feeder, or where planned development calls for an entry of excessive length, a No. 2 cable is used instead of the No. 6. Section feeder cable protection is provided by an oil circuit breaker at the junction of the 4/0 and 6/0 cables.

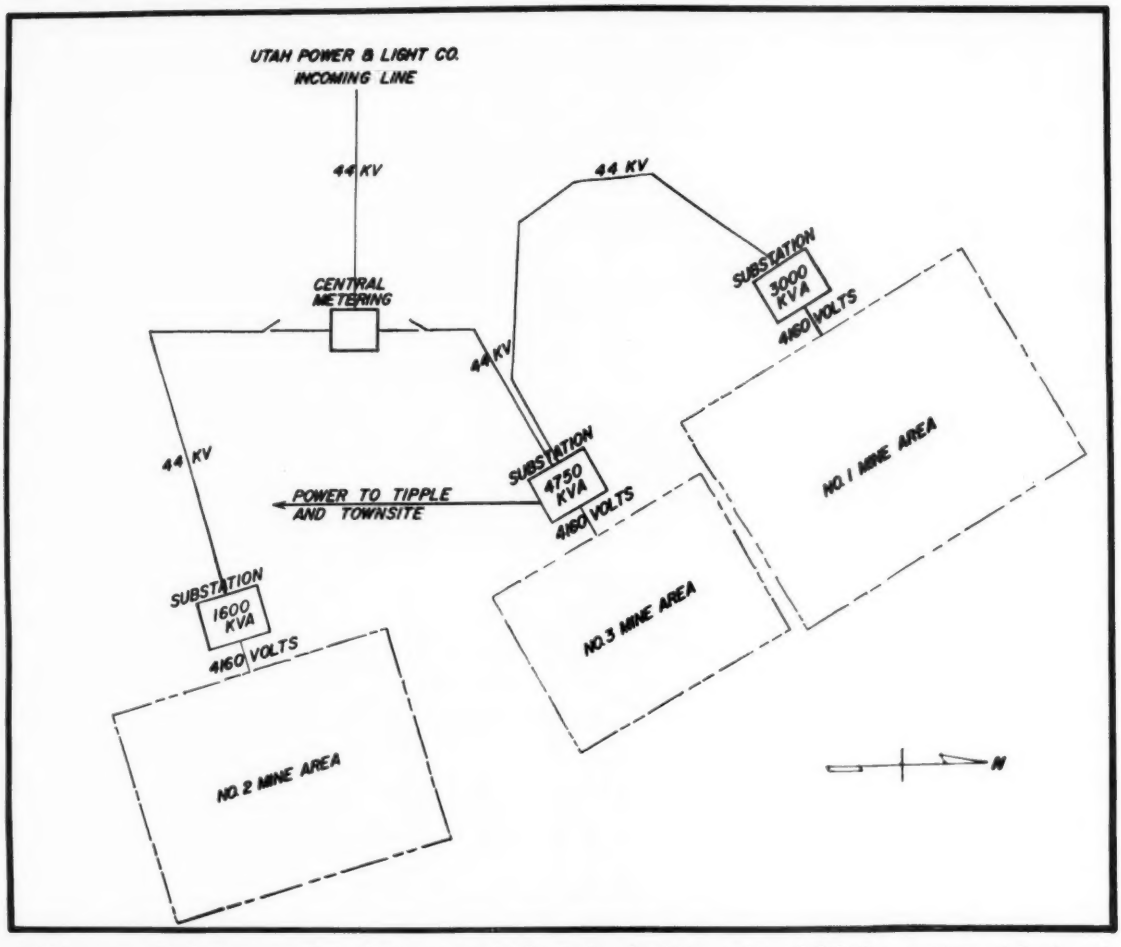
The 4160-volt power is transformed to the utilization voltage of 480 volts by a 200-kva portable mine load center substation located in the immediate face area. This substation includes a primary oil circuit breaker, a transformer section connected 4160 delta primary to 480 wye, voltage taps, and outgoing cable connectors. The power for the face equipment is taken from the 200-kva transformer at 480 volts and transmitted through 200 ft lengths of 4/0, four-conductor cable to a junction box. The junction box is equipped with separate plug-in connections and circuit breakers selected to protect the trailing cables and the equipment which the cables feed. These junction boxes can be omitted by connecting the trailing cables directly to secondary circuit breakers built into the mine load substations. Both type of mine load center substations are used. However, under normal conditions, the use of a junction box eliminates the need for frequent moves of the heavier mine load substation and also permits the use of shorter trailing cables.

At the present time a continuous mining unit is being fed directly from the mine load center substation without the use of an intermediate junction box. This type of electrical distribution was selected because of special mining conditions. In this case slopes are being driven straight up the pitch using a continuous miner, an 11 BU loader, a 25-hp shuttle car, and a 50-hp rope-suspended conveyor. When the slopes are finished, they will be approximately 2500 ft long. The belt line is extended 225 ft at a time to keep the length of shuttle car travel to a minimum on steep grades. The 200-kva load center unit with built-in circuit breakers is always located at the top end of the conveyor and is moved with the conveyor. A No. 6, 4160-volt cable suspended with messenger wire feeds the transformer. This arrangement keeps the length of the 480-volt trailing cable within the desired length of 500 ft.

All of the face equipment is protected with ground fault relays. Two types are being used at Sunnyside—one a selective trip arrangement which only disconnects the trailing cable that is grounded, the other a nonselective type which interrupts all power from the junction box to the face in the event of a ground fault on any trailing cable. Although more expensive, the selective type has proven the most satisfactory.

Face Equipment

Typical section equipment for a continuous mining unit would include: a 166-hp ripper type continuous miner, a 54-hp 11 BU pick-up loader, a 60-hp M-G set, 101-hp DM-8 roof bolting machine or a 50-hp compressor for bolting equipment and a 15-ton trolley locomotive. All of this equipment, with the exceptions of the shuttle car and trolley locomotive, is 440 volt a-c powered. D-C power for the locomotives is supplied by 500-volt mercury-arc rectifiers strategically lo-



Outside power distribution—general protective equipment for each substation consists of lightning arresters, air-break and fused disconnect switches on the 44-kv line and automatic reclosing oil circuit breakers and lightning arresters on the mine feeder lines

cated throughout the property. Shuttle car power, in the case of the 500-volt cars, is obtained from the 500-volt trolley line. Portable 40-kw, 250-volts M-G sets supply power for the older, 250-volt shuttle cars. A-C shuttle cars are now being considered and should these be used, the distribution system would be further simplified.

Since correct voltage at the face is necessary to insure maximum equipment life and performance, considerable attention is given to maintaining 440 volts at the equipment. This is accomplished by the use of load voltage regulators at the outside substation, adjustments of tap changers on the section mine load center substation, and proper selection of cables. The length of the 4/0 cable from the transformer to the junction box is normally held to 600 ft or less and the trailing cable to 500 ft, but cases have arisen where 1200 ft of the 4/0 and 500 ft of trailing cable have been used without encountering any serious troubles.

All continuous miners at Sunnyside are equipped with a No. 1, three-conductor trailing cable which includes a No. 6 frame ground wire. The first a-c continuous miner used was operated on 220 volts. Standard equipment for this machine included a 400,000 CM cable which was so heavy that it was very difficult to move and almost impossible to keep on hangers to protect it from damage. A power study was made on this machine while in operation and it was decided that 4/0 cable could be used if kept under 600 ft in length. This practice was followed until the State laws were changed to permit the use of 440 volts underground. Since that time, the miners have used only the No. 1 cable as described.

Problems necessitating adequate power as well as a flexible power supply to the face machinery are generally the same as encountered throughout the industry. Frequent moves to allow installation of roof support are the practice. Grades, when working up the pitch, sometimes run as high as 20 percent. The cutting qualities of the coal vary greatly in the three mines and water problems are encountered when working down the pitch or in the lower entries.

Advantages of A-C

Of the first two continuous miners in operation at Sunnyside, one was a-c powered and the other d-c. All miners purchased since this time have been a-c machines. Therefore, only a limited comparison can be made, but

from this experience the a-c electrical system was found to have the following advantages:

1. **Initial cost** of a-c motor and utilization equipment is considerably lower than equivalent d-c equipment. For examples, a-c motors are less than one-half the cost of d-c motors, 440-volt a-c motor control costs less than d-c, a-c substations are less than one-third the cost of d-c conversion units, cable cost is lower for an a-c system because less copper is required to distribute power at the higher voltages.

2. **Operator training** requires less time on a-c machines than on similar d-c miners.

3. **Continuity of production** definitely favors the a-c machine because of less down time.

4. **Maintenance** of the d-c machine is excessive when compared with the a-c counterpart. The d-c machine had more motor failures than all ten of the a-c miners. The armatures, fields, brush-holders, brushes, resistances for two-step acceleration, mercury tubes for contactor sequence, and the contactor required for the d-c machine made a detailed inspection much more time-consuming than on a-c machines. Equal division of load between the two cutting motors was harder to achieve with the d-c miner. Similar maintenance advantages on other utilization and distribution equipment were also experienced.

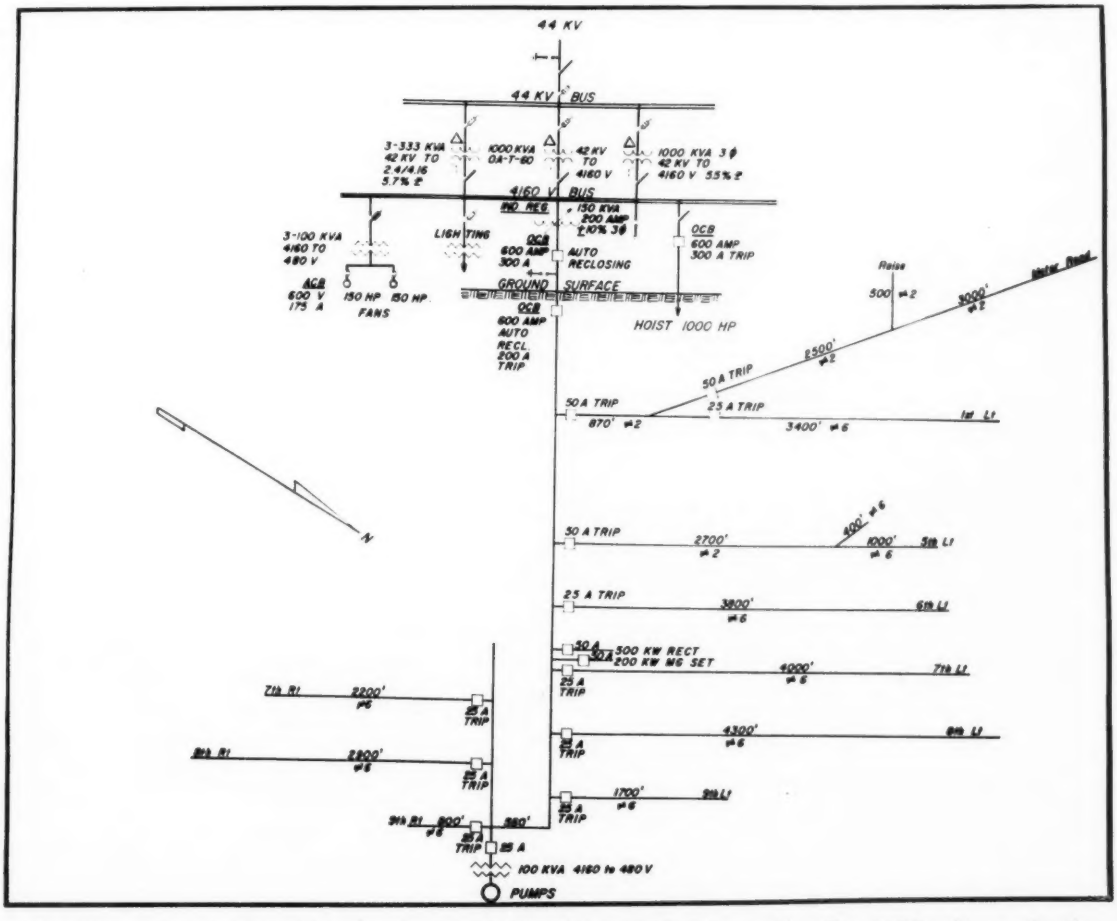
5. **Safety** of the a-c system is believed to be superior to the d-c because of the use of quick acting, low current, ground fault relays on all face feeders.

6. **Flexibility** of power distribution, to cope with a relatively fast moving face when using continuous mining equipment, is one of the strong points of the a-c system. Distribution of power to the utilization point with high voltage a-c requires less time and effort for necessary moves and is more economical.

Advisable to Standardize

Although there are three mines at Sunnyside, they are essentially one operating unit. These mines are serviced by one supply center and a central outside maintenance department. Because of these factors, it was advisable to standardize to either a-c or d-c mining.

At the early stages of the operating it would have been possible to modernize along the lines of either electrical system. The experience gained while operating both a-c and d-c continuous miners indicated that the a-c system afforded the most economical and productive operation for this property. The adopted system has proven to be very satisfactory over the last few years, even in the face of ever-increasing production demands and larger power requirements in the section.



The 4160 voltage is transmitted into the mine through 4/0 rubber-covered primary cable. One 1500-ft cable supplies the power to the main hoist and a separate cable supplies the working sections of the mine

Describing the operations of well over a dozen uranium mining companies and all of the uranium mills in the New Mexico area, an engineer who has pioneered in the district from its beginning traces the growth of a mining bonanza in . . .

The Grants and Ambrosia Lake Areas

By T. O. EVANS
Chief Mining Engineer
Atchison, Topeka & Santa Fe Railway Co.

THIS article will deal with some historical facts, along with other information, concerning the Grants, Jackpile and Ambrosia Lake areas in New Mexico. All of these districts are in the northwestern part of the State, a few miles north of the Santa Fe Railroad and U. S. Highway 66 between Albuquerque and Gallup. Grants, a town which grew from about 2500 to approximately 6000 population in the last few years, is the center of activity and most of the companies operating in the district have offices there.

First Major Uranium Discovery in New Mexico

The Grants area will be discussed first. It was in 1950 that the author went to Grants to investigate and report upon a uranium occurrence discovered by a Navajo Indian named Paddy Martinez.

Paddy knew nothing whatever about uranium until he heard two prospectors discussing the subject at a lunch counter in Grants. One prospector told the other that he had no idea as to what uranium looked like and he was wondering where he could obtain a sample.

The other prospector informed him that he had a piece in his pocket which he would be glad to show him. Whereupon he handed the first prospector a piece of yellow colored sandrock which he said was carnotite.

When Paddy Martinez saw the yellow colored rock, he remembered that he had seen some rocks similar in color in an outcropping south of Haystack Mountain—a butte resembling a haystack—located about 18 miles west of Grants.

Within a few days, Paddy returned to Haystack Mountain, where he had sheep pastured. He broke off several pieces of the yellow rock which he later took to a Grants merchant for identification.

Of course the merchant could not classify the rock, so he sent it to the Colorado School of Mines where it was indentified as tyuyamunite, a calcium uranium vanadate. Incidentally, this was the first major uranium discovery in New Mexico, and since it was made upon Santa Fe lands, it became the writer's duty to learn something more about it. This he proceeded to do on September 20, 1950.

The investigation revealed seven disconnected mineralized outcroppings of tyuyamunite in the Todilto limestone of Jurassic age, which overlies the Entrada and underlies the Morrison formation. The mineralized outcroppings were scattered over a distance of about 18 miles. Samples were cut and the assays indicated the grade of ore to be between 10 and 40 one-hundreths of one percent U_3O_8.

Following the examination, it was concluded that the district was an interesting one, because of the widespread occurrences. Believing that additional ore would be found, we recommended to the management of the Santa Fe that a comprehensive program of exploratory drilling was justified in order to more completely evaluate the possibilities of discovering additional ore.

One Million Dollars for Exploration, Development

Since there were only a few one hundred thousand ton deposits in this country prior to 1950, it was the opinion of F. G. Gurley, president of the Santa Fe Railroad, that possibly the company could render a valuable service by assisting the Atomic Energy Commission in its search for additional uranium ore reserves.

That statement explains the reason why Santa Fe concluded to undertake the exploration and development of uranium occurrences on its railroad lands.

Drilling programs in the search for uranium involve considerable expense. Members of the Atomic Energy Commission have acknowledged that the commencement of the phenomenal development of the Grants district originated with Gurley's wise decision

to explore its ore producing potentiality by authorizing the expenditure of approximately one million dollars for exploration and development of Santa Fe lands. This money was spent before the company sold one lb of ore.

Reserves in the Grants district now total about two-thirds of the presently known ore reserves in this country. Santa Fe's reserves at Haystack and Poison Canyon are insignificant when compared to the total tonnage; however, some of its lessees have developed substantial tonnages, and the company derives considerable satisfaction from their success.

Initially, Santa Fe drilled the Todilto limestone occurrences, but following the discovery of carnotite-type ore in the Brushy Basin sandstone member of the Morrison formation at Poison Canyon, on January 4, 1951, it has carried on an extensive program in that area. Mining engineers of the Santa Fe were the first to prospect for, and discover, ore in the Morrison formation in the Grants district.

Pilot Plant Amenability Tests

Almost three years elapsed between the commencement of the company's exploratory drilling program and the first shipment of limestone ores to the Anaconda mill. Practically all of this time was spent in pilot plant amenability tests to determine a satisfactory process to recover the uranium from the limestone gangue ores, and in the construction of the carbonate leach plant by the Anaconda Co. This plant has a daily milling capacity of 500 tons.

By a contractural arrangement between Anaconda and the Haystack Mountain Development Co., (a wholly owned subsidiary of the Santa Fe) Haystack is obliged to ship all of its limestone ore to the Anaconda mill at Bluewater, which is approximately nine miles from the deposit.

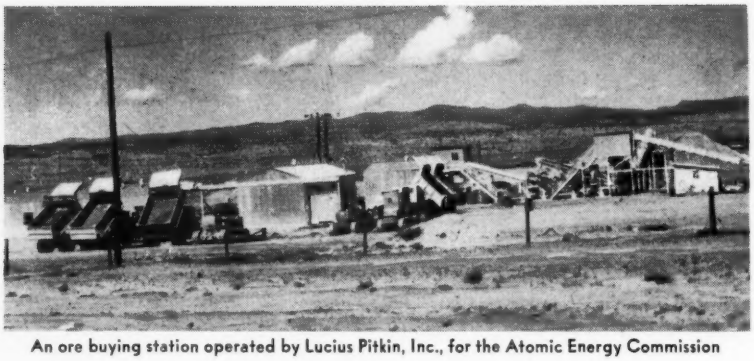
Sandrock ore produced at our Poison Canyon mine is shipped by truck to the Shiprock mill of Kerr-McGee Oil Industries, Inc. Prior to this arrangement with the latter company, ore shipments were being made to the Bluewater Receiving Station, operated by Anaconda on behalf of the Atomic Energy Commission.

Limestone Mining Costs Higher

All of our limestone mining is done in open pits after removal of about six or seven ft of overburden by bulldozers. The mineralized limestone averages about five ft in thickness. Drilling is done by wagon drills, and after blasting the ore is loaded into trucks by a ¾-yd Link Belt power shovel. Two Allis-Chalmers HD5 end loaders are used for ore blending.

Until recently, all of the sandrock ore was recovered by open pit methods, similar to our limestone operations. However, the average depth of over-

Approximately 25 tons of uranium ore are being loaded in this large truck at the mine shaft of Rio De Oro Uranium Mines' Dysart Mine No. 1 in the rich Ambrosia Lake region



An ore buying station operated by Lucius Pitkin, Inc., for the Atomic Energy Commission

burden that had to be removed at Poison Canyon amounted to 30 ft and the ore was about six ft in average thickness. After drilling and blasting, two, one-yd Allis-Chalmers end loaders were used to load the ore into trucks for delivery to the blending piles, and one, one-yd HD11 loaded the ore into trucks for delivery to the mill.

Our mining costs for the past year have averaged $3.01 for the limestone and $2.76 per ton for the sandrock. The limestone is somewhat harder to drill and more powder is used in blasting than in the sandrock deposit. The costs that have been supplied include all items involved.

For the past six months, Santa Fe has discontinued surface mining at Poison Canyon except in one instance, and most of the ore produced comes from underground. Jackleg drills are used for drilling. An Allis-Chalmers HD5 end loader and an Ingersoll Rand ten-hp slusher are used for loading the ore into 3 four-ton shuttle cars which convey the ore up a 15 percent inclined rock cut to the blending piles. Three Joy, five-hp blowers furnish about 25,000 cfm of air for ventilation.

Six other companies are operating in the vicinity of the Haystack and Poison Canyon mines. They are the Holly Uranium Corp., Mid Continent Uranium, Rim Rock Mining Co., Dalco Corp., Four Corners Exploration Co. and the Westvaco Chemical Co.

About three miles to the east of Poison Canyon, the Calumet & Hecla Corp. have recently let a contract to sink a 1200-ft inclined shaft on a gradient of ten percent to tap a rather extensive ore body in the Westwater sandstone.

All of the properties mentioned are generally referred to as being in the Haystack Mountain or Poison Canyon areas.

Jackpile Open Pit Mine

The next district to be given a brief review is within the limits of the Laguna Indian Reservation where Anaconda's famous Jackpile mine, located 45 miles east of Grants, was discovered in November 1951 by aerial reconnaissance, employing scintillation equipment.

Subsequently the deposit was proven by an extensive drilling program which has demonstrated it to contain the largest tonnage of uranium ore thus far developed in this country.

The initial exploratory drilling revealed two ore horizons of enormous extent in the Westwater member of the Morrison formation, and subsequent drilling has continued to expand the ore body to the north; consequently, the ultimate size of this occurrence is not presently known.

In considering whether or not it was more advantageous to sink shafts or remove some 125 ft of overburden overlying the deposit to recover the ore, the Anaconda management decided upon stripping. It was their opinion that approximately 20 percent more ore could be recovered by open pit operations.

A contract to strip part of the area was given to the Isbell Construction Co. and Anaconda removed the balance. To date, approximately 25 million tons of material, most of which requires blasting, has been stripped.

Anaconda employs six power shovels ranging in dipper capacity from 1½ to 6 cu yd. In addition, 27 twenty-two ton Euclid trucks are used for the transportation of ore and stripped material. The labor force totals about 200 men.

The mined ore is removed by trucks to the crushing plant located on a standard gauge railroad spur track. After crushing the ore, it is loaded into 70-ton gondola cars for shipment to the Anaconda processing plant at Bluewater, which is about 50 miles from the mine. The spur track built by Anconda, from the main line of the Santa Fe to its Jackpile mine is about five miles in length.

Device Determines Average Grade of Each Carload of Ore

A novel, effective method of weighing and grading the ore has been in use at the ore crushing and loading plant since last March. After crushing, the ore is conveyed on a belt provided with a weightometer to determine the weight of ore passing to the loading chutes. As the ore travels along on the conveyor belt, it passes beneath an electronic device installed by the Eberline Instrument Co. The emanations of radioactivity emitted by the ore are recorded in counts per second. When exactly 70 tons of ore has been dumped into the gondola, the Eberline Instrument automatically prints a ticket indicating the average grade of delivered ore, as well as the weight and lot number of the loaded car.

Of course, each carload of ore is later sampled at the mill to determine the actual grade and this information is relayed to the crushing plant to recalibrate the instrument, which is seldom necessary.

The information supplied by the Eberline Electronic equipment enables the mill supervisors to know with accuracy the grade of each carload of ore, and this information permits them to blend the contents of the car with higher or lower grades at the unloading bins for their mill heads control.

It was previously mentioned that Anaconda operates a limestone unit capable of processing 500 tons of limestone ore. This plant was put into operation on October 1, 1953.

Following the development of the Jackpile mine, Anaconda built an additional mill to process their sandstone ores. This mill was placed in

(Continued on page 70)

Reserves in the Grants-Ambrosia Lake district now total about two-thirds of the presently known ore reserves in our country

when you put Bowdil Bits

in a Bowdil Chain

on a Bowdil Bar . . .

you find your greatest economy.

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Overburden Drilling and Blasting

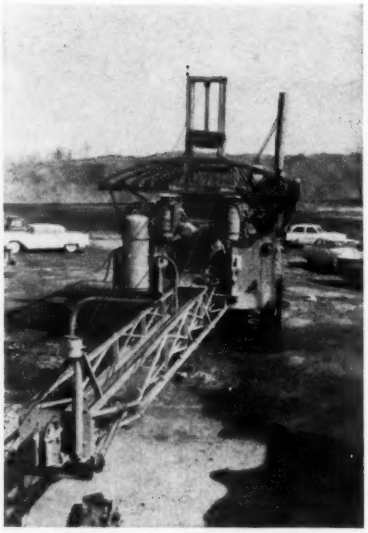
With Ammonium Nitrate Explosives

A discussion of the drilling and shooting problems, practices and results of the various stripping operations of the Peabody Coal Co.

By FRED HORNE
Explosives Engineer
Peabody Coal Co.

THE fairly wide geographic distribution of the Peabody stripping operations provides enough variation in overburden formations to require the use of numerous types of drilling equipment and drilling systems or patterns. So much has been written and said during the past few years concerning rotary drilling that a newcomer to the industry might be inclined to believe that this method of drilling had completely replaced all other methods—this, of course, is not true, because the auger drill still accounts for millions of yd of shot bank. To illustrate this point, a summation of the total yardage shot at all Peabody stripping operations during the month of December 1956 shows a total of 8,290,769 cu yd shot from auger drilling; 1,287,829 cu yd shot from rotary drilling, and 50,642 yd shot from percussion drilling.

Auger drills and accessories have been improved over the years by such things as variable speed rotation and tungsten carbide tipped bits, but there are still stripping operations where the drills, augers, drill heads and bits being used have had very little modification in the last quarter century. Where the nature of the overburden is such that these old type drills have application, faster and much cheaper drill footage is obtained than would be possible with a more modern drill requiring much more capital investment. The drilling ability of the auger drill ends with sandstones of extreme hardness, limestone, heavy layers of sulphur balls commonly called niggerheads, conglomerates of indeterminate nature, and other localized formations of excessive hardness and abrasiveness.

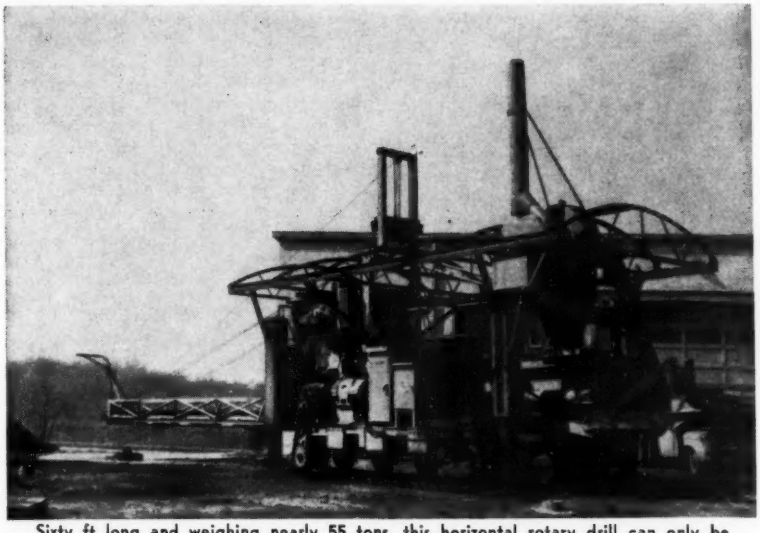


Some knowledge is yet required concerning the adjustment of hole spacings, but the results of tests made with this horizontal rotary drill have shown that even in high shale overburden enough back break can be obtained with a 48-ft hole to dig a pit 65 ft or more in width

Percussion drilling is used only for thin hard formations such as rock partings between coal seams or a thin but very hard slate formation above the coal from which all of the overburden has been removed without requiring any shooting. Percussion drilling and close hole centers go hand and hand, resulting in a high unit cost for shot yardage. Considerable thought and discussion has been given to the replacement of percussion drilling with rotary drilling.

Vertical and Horizontal Blast Holes

To cope with such a variety of overburdens the Peabody stripping operations are using or have used numerous drilling systems. These systems



Sixty ft long and weighing nearly 55 tons, this horizontal rotary drill can only be successfully operated on a full pit of coal following the stripping unit. After some modifications are made, the drill is expected to have a potential of 20 holes per eight-hour shift, using only one man

include vertical drilling, horizontal drilling, and combinations of vertical and horizontal drilling, with numerous variations within each system. Vertical drilling is done both against an open high wall and against a shot buffer. Horizontal drilling is varied by sometimes drilling every other hole with an upward angle and by sometimes drilling an upward angled hole directly above the horizontal hole. This latter variation has successful application where a seam of hard rock such as limestone lies close to the coal and has considerable cover above it. A horizontal hole drilled under the limestone produces good fragmentation of the limestone itself, but in so doing much of the explosive energy is dissipated so that very poor fragmentation is obtained in the high cover above the limestone. The upward angled hole drilled above the limestone is required to take care of this condition. By drilling the high hole directly above the horizontal hole, the necessity of resetting the drill can normally be eliminated. Still another variation of using the horizontal drill is to angle all the holes upward.

Combinations of vertical and horizontal drilling consist of one or more rows of full depth vertical holes drilled behind a row of horizontal holes, or a pattern of partial depth vertical holes drilled directly above a row of hortizontal holes. All of the drilling systems mentioned have certain advantages and likewise all of them have some disadvantages.

Shooting Against a Buffer

There are several advantages to be found in using the system of vertical drilling and shooting against a buffer of shot overburden. To begin with, the large chunks of overburden that occur when shooting against an open solid face, either vertically or horizontally, are eliminated. The long toe that cannot be shot at all is eliminated. The drill is never required to work dangerously close to the edge of a highwall in a futile attempt to shoot a toe that may be as much as 50 ft from the bottom of the hole, or an even greater distance in very deep overburden. A uniform pattern of drilling can be maintained, since regardless of how crooked a pit is when first opened, adjustments made on the first and second pits, where any deviation in hole spacing is less apt to cause trouble, result in long, straight rows. A uniform drilling pattern is impossible when the crooked edge of the highwall must be used as a baseline for each pit.

After sufficient buffer has been established to put the drill well ahead of the stripping unit, other advantages accrue. In periods of dry weather the drill can be worked in areas of the highwall that would be very muddy or boggy in wet weather, and during periods of wet weather the drill can be worked on ridges, hill tops, or areas where rock is close to the surface. Where advance preparation of the highwall is required for moving the drill, felled timber and brush can be pushed upon the buffer area and will then require no rehandling.

In addition to the elimination of chunky material, this system provides further advantages for the stripping unit. Depending upon the amount of spoil room available, the stripping unit operator can widen or narrow the pit being dug to the best advantage of the machine, without, in any way, interfering with the drilling and shooting. Better slopes can be made on the highwalls, thereby eliminating many slides that occur when a high and hard but cracked overhang is left on the highwall. In spite of all the advantages listed for the buffer system, it sometimes requires considerable argument with a stripping operator not familiar with the system to even convince him that it is workable.

Trend Toward Larger Diameter Holes

Regardless of whether auger or rotary drilling is used, there has been almost a complete change in the past few years to large diameter holes. Many readers will be able to remember when a hole five in. in diameter was about the largest size drilled, and some readers will even be able to remember when holes required springing to be able to load enough explosives in them. A five in. diameter hole is now the smallest size drilled at Peabody stripping operations. Using horizontal auger drills, bore holes range from five to nine in. in diameter, and a horizontal rotary drill is used to drill 7⅞ and 9 in. diameter holes. Using vertical auger drills, bore holes range from 6 to 9 in. in diameter, and vertical rotary drills are used to drill 10⅝ in. diameter holes.

Many factors have contributed to the trend of increasing hole diameters. Large diameter holes normally allow wider hole spacings, resulting in a decreased labor cost and the ability to stay ahead of larger stripping units. It should be pointed out that there are some conditions that do not allow the spreading of hole centers, even though a large diameter hole is being drilled Such a condition would exist when a very hard formation in the bank was quite thin. In actual practice, holes 10⅝ in. in diameter have been drilled on centers as close as 15 by 18 ft to successfully break a layer of niggerheads directly above the coal and varying from three to six ft in thickness. The large holes have allowed the use of bulky and cheaper explosives. Some of the explosives used successfully in large holes cannot be consistently detonated in sizes less than six in. in diameter. This fact was proven the hard way by actual failures in the bank—but in all fairness it should be stated that it was done over the protest and advice of the manufacturer. It is, of course, a matter of common knowledge that an increase in cartridge diameter of any type of ammonium nitrate explosive results in better performance characteristics.

The manufacturers of explosives have also had a hand in causing the switch to large diameter holes by establishing a price differential on size

in certain types of explosives. These price differentials occur on diameters of five, six, and seven in., and it can be stated as a generality that an explosive delivered in seven in. diameter cartridges will normally cost one dollar less per 100 lb than the same explosive in five in. diameter cartridges.

Cost and Footage of Vertical Drilling

Some data on bit footages and costs for vertical rotary drilling may prove of interest. At an operation in Western Kentucky where the overall formation averages 14 percent topsoil and clay, 27 percent shale, and 59 percent sandstone, Hughes W7RJ 10⅝-in. bits were used at first. These bits produced an average of 7715 ft before the cutting rollers became too dull for adequate penetration, for a bit cost of $0.0373 per ft. At this operation the sandstone is not extremely hard, so a switch was made to OSCJ 10⅝-in. bits, resulting in faster penetration and an average bit life of 10,456 ft and a bit cost of $0.0275 per ft. The maximum footage ever drilled at this operation in a single eight-hour shift (7½ hours working time) was 1062 ft, and the average shift footage is 684 ft.

Another operation in Western Kentucky has overburden averaging 22 percent topsoil and clay, 37 percent shale, and 41 percent sandstone. W7RJ 10⅝-in. bits produce an average of 7926 ft of bore hole, for an average bit cost of $0.0356 per ft. Hard sandstone and some especially hard conglomerate prevent the use of any other type of bit. The maximum footage drilled in an eight-hour shift was 1036 ft, and the shift average is 660 ft.

At an operation in Illinois a 33-ft auger using a 12-in. drill head drills through the topsoil and clay and then a W7RJ 10⅝-in bit finishes the hole, drilling an average of 30 percent shale, 20 percent slate, and 50 percent limestone. On a very few holes where the auger will not drill completely through the clay, a small amount of clay is drilled with the W7RJ bit, but percentagewise the amount is so small that it will not be considered. Under these conditions, bit life has varied from a low of 1030 ft to a high of 11,277 ft with an average of 5177 ft for 11 bits, and an average bit cost of $0.0570 per ft.

It is interesting to note that as the drillers have gained experience, that under the same drilling conditions bit life has shown a steady increase. The maximum footage for a single eight-hour shift, including the auger drilling was 721 ft, and the shift average is 550 ft. In many of the holes drilled the clay is so wet and sandy that it squeezes partially together during the rock drilling. To be able to load these holes it is necessary to ream the hole with the auger as the final operation, and the time required for the second run of the auger naturally decreases the total drill footage.

Bit Life

At an operation in southern Indiana all the drilling was done with a W7RJ 10⅝-in. bit on a shale bench from which all the topsoil and clay had been removed. Approximately two ft of limestone was cut in each hole plus a layer of extremely hard niggerheads ranging from three to nine ft in thickness. The remainder of the bench was an easy drilling shale, and since the total depth varied from 20 to 90 ft plus, the percentages of hard drilling formations in the holes would have great variation. Bit life ranged between 18,000 and 23,000 ft, and at current bit prices the bit costs would range from $0.016 to $0.012 per ft.

Bits are considered as worn out when the bearings fail, although some of these bits still retain some cutting life in the rollers. The writer has no knowledge of this condition having been altered by any operator. In certain abrasive formations the rollers lose their cutting ability while the bearings are still serviceable, and under this condition the operator can help his overall bit cost by having the rollers built up. While it is true that bits are only leased to the operator rather than sold outright, the lease is for all the life that the bit can possibly have, so the writer feels that the subject of rebuilding the rollers need not be an undercover subject as it has been for so long. It has been found that better results are obtained from having welding shops specializing in this type of work rebuild the rollers, since special equipment and knowhow is needed.

At the operation described above where the bits had to be taken out of service after drilling an average of 7715 ft for a bit cost of $0.0373 per ft, the same bits after being rebuilt drilled an average of 7345 ft for a bit cost of $0.0102 per ft. It might be argued that it would not be proper to use only the cost of rebuilding the bit (approximately 26 percent of the original cost) for determining the bit cost per ft, but since the bit when taken out of service could no longer produce footage, the cost of rebuilding did in effect produce a new bit. Considering the total average footage drilled per bit, the bit cost is $0.0241 per ft. So far no bit has been rebuilt more than one time.

Horizontal Rotary Drilling

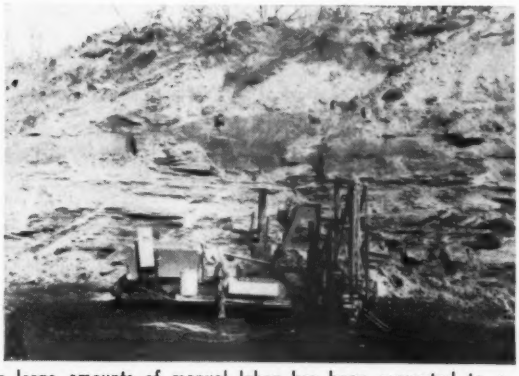
Late in 1954 the first commercially manufactured horizontal rotary drill was put in operation at an Illinois pit to drill 7⅜-ft holes in the limestone above the No. 6 coal seam. Very little was known about this method of drilling at that time, but it was quickly determined that it was practical. At first, auger sections 9 ft 2 in. in length were used, but these were eventually replaced by smooth drill stems the same length, retaining the auger flights only on the section following the bit.

With the large percentage of hard limestone drilling, the first stem couplings wore badly, allowing a great deal of air leakage, and were very prone to breakage, resulting in many auger sections being lost in the bore holes. These augers were heavy and had a very shallow flight dimension which made them very difficult to retrieve when lost in the bore hole. The original air compressor was not of sufficient capacity, and that fact coupled with the leakage at the stem couplings resulted in very poor bit footages. Eventual replacement of the stem couplings with API boxes and pins and the addition of more air capacity produced solutions for these problems. The final major disadvantage that could not be overcome was the amount of time required for handling the auger sections.

A single drill helper using an electric hoist could make and break the tool string, but the two operations consumed almost as much time as the actual penetration. It was then decided that a single drill stem long enough to drill a full depth hole would not only eliminate this lost time but would make possible the use of a driller without a drill helper. Since this plan involved an entirely new and unproven method of horizontal drilling, it was decided that the most desirable economic approach was to modify the original drill to use a single auger 60 ft in length. This modification was accomplished in 1956 and the drill shipped to an operation in southern Indiana where the formation to be drilled was a fairly soft shale but heavily laden with small niggerheads.

While the drill stem to be used was 60 ft long, only 48 ft of hole could be drilled, and since this drill was to be used in overburden up to 75 ft deep, consisting mainly of shale with a shallow clay cover, it was obvious a larger diameter hole was required. The 7⅜-in. bit was replaced with a nine-in. bit and a penetrating speed of as much as 50 in. per minute was obtained. The drill was operated only a few weeks to prove the practicability of both the drill and the use of comparatively short horizontal holes in deep overburden.

Both the drill and the short holes showed enough promise to justify a decision to make another major set of modifications on the drill, principally to increase the speed of a few operations and to add a few refinements that would completely insure the drill being a one man opera-



The only remaining operation in the strip mining industry requiring large amounts of manual labor has been converted to a mechanized operation at a southern Indiana mine by installing machines to load and tamp horizontal holes

tion. Since these modifications are still in progress the article will contain no performance data on the drill. Based on some shifts of performance during the test period, it seems reasonable to predict that when the drill is put back in operation it will have a potential of 20 holes per eight-hour shift, using only one man.

The overall length of the drill is the drill stem length of 60 ft, and the drill will eventually weigh close to 55 tons, so the only place it can be successfully operated is on a full pit of coal following the stripping unit. Any future drill will be designed to take more advantage of the drill stem length. For example, preliminary discussions have indicated that a drill with an overall length of 65 ft could possibly drill a hole 60 ft deep.

When this drill can drill through solid bank the full depth of the hole, the hole is extremely clean. Holes are drilled very straight and do not drift in the direction of rotation as auger drilled holes do. The clean holes allow easy loading of eight-in. cartridges and in most of the holes 8½-in. cartridges could be loaded. This condition allows a concentration of explosives toward the back of the hole, and a corresponding long column of stemming which makes the explosives work in the back of the hole rather than blowing off the face. Some knowledge is yet required concerning the adjustment of hole spacings, but the results of the tests have shown that even in high shale overburden, enough back break can be obtained with a 48-ft hole to dig a pit 65 ft or more in width.

Types of Ammonium Nitrate Explosives

If the term "Ammonium Nitrate Explosives" is considered in the broadest sense to include ammonium nitrate dynamites, in which various percentages of the nitroglycerin have been replaced by ammonium nitrate, as well as the explosives consisting of various grades of ammonium nitrate reinforced with oxidizable materials such as carbon black, coal dust or fuel oil, and in some cases sensitized by additives such as nitromethane, then it can be stated that practically all fixed explosives now used by the strip mining industry can be so classified.

With so many ammonium nitrate explosives available, the stripping operator has a wide choice of performance characteristics. Ammonium nitrate dynamites range from 20 to 65 percent strengths. Based on a stick size of 1¼ by 8 in., the rates of detonation range from 8000 to 13,000 ft per second, and these rates increase considerably as the stick diameter is increased. The dynamites will propagate on a gap space of about six in. and can be detonated with blasting caps or detonating fuse. Such explosives as Akremite, the Nitro-carbonitrates and Methanite, used where they have application, will produce fragmentation equal to that produced by dynamites having up to 65 percent weight strength. The rates of detonation of Akremite confined in ten-in. holes range between 12,000 and 14,750 ft per second.

With all of this variation in performance characteristics and physical properties, no single explosive among this group can be designated as an all purpose explosive, capable of good results in all types of overburden and usable in all kinds of loading conditions. In some explosives a characteristic or property that is desirable under one condition can actually be detrimental under other conditions.

Comment should be made concerning the natural tendency of stripping operators to decrease the costs of expensive primers by using primers of less weight or lower strengths. The explosives which require priming seem to yield final results in direct proportion to the amount and character of initial detonation. Specific examples include an explosive producing excellent fragmentation when detonated with a 12½-lb primer, which resulted in a large percentage of misfires when the primer weight was decreased to 6¼ lb, and an explosive which produced very poor fragmentation when detonated with a primer of 40 percent strength, and very good fragmentation in the same overburden when a primer of 50 percent strength was used.

Horizontal Costs Per Yd—$0.0105 to $0.0681

To present some actual physical data and blasting ratios with resulting costs, an analysis was made of the drilling and shooting reports of all the Peabody stripping operations for the full year of 1956. Since horizontal drilling and shooting accounted for the greatest percentage of shot yardage, it will be discussed first. Hole spacings varied from 12 to 33 ft. At this point it would be in order to comment on the fact that caution is required in decreasing horizontal hole centers in high overburden. When the shot gets badly out of balance by having the distance between holes very small as compared to the depth of cover above them, there is always the problem of shots shearing or whipping across to adjacent shots. Here, again, is an example of the advantages of large diameter bore holes, in that proper amounts of explosives can be loaded in the bank without the necessity for close hole spacings.

Holes were drilled to depths ranging from 30 to 90 ft. The minimum depth of 30 ft was not common, and in general, holes for shovel pits varied from 45 to 70 ft, and for dragline pits from 80 to 90 ft. Bank heights were between the limits of 12 and 82 ft. Explosives were loaded in these holes with blasting ratios running from a minimum of 3.18 cu yd of overburden per lb of explosive to a maximum ratio of 19.21 yd per lb. With this wide variation in blasting ratios and the wide variation in explosive prices, the explosive costs

per yard were $0.0084 for a minimum and $0.0437 for a maximum.

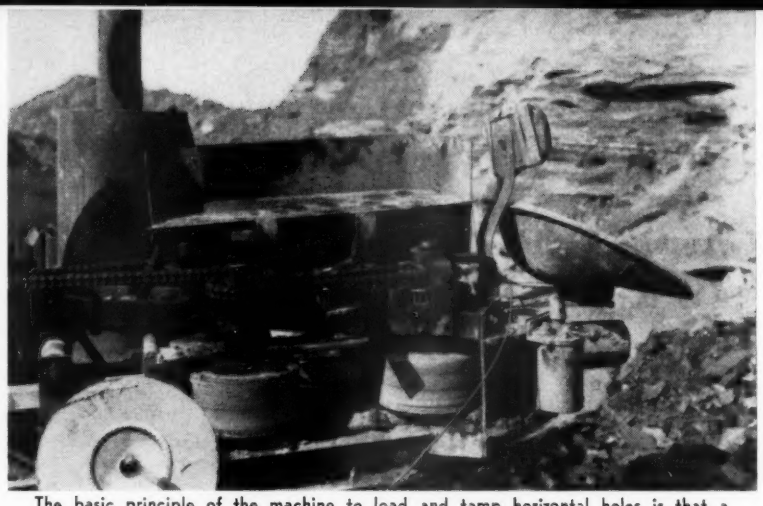
Explosive cost per yard includes the cost of the explosive and primer, and the cost of all blasting accessories, such as detonating fuse, blasting caps, MS connectors, fuse clips, and tamping bags. Total cost per yard includes, in addition to the explosive cost per yard, all labor costs for drilling and loading, all drill and tamping machine maintenance (including labor as well as parts and material), bits, power, and any other costs not directly included in explosive costs. Total costs per yard for shot overburden ranged from $0.0105 to $0.0681.

Costs of Vertical Method Higher

Vertical hole spacing varied from 12 by 15 ft to 40 by 40 ft, and hole depths from 10 to 86 ft. Blasting ratios varied in a wide range from a minimum of 0.882 cu yd of overburden per lb of explosive to a maximum ratio of 12.15 yd per lb, resulting in a wide range of costs. Using the same cost factors that were used to determine the horizontal explosive costs per yard, the vertical explosive cost per yard ranged from $0.0135 to $0.0984. To the same cost factors involved in the horizontal total cost per yard of shot overburden was added the cost of surface preparation necessary for drill movement, resulting in a minimum total cost per year of $0.0198 and a maximum total cost per yard of $0.1384. Considering the two methods on a comparative basis, the unit costs of the vertical method normally exceed the unit costs of the horizontal method. The higher costs of the vertical method are, in many cases, more than offset by the quality of fragmentation obtained, and the overall general results of the stripping operation.

The shooting of thin formations, whether drilled by percussion or auger methods, result in high unit costs when compared to unit costs of regular overburden shooting. Thin formations were all drilled vertically on spacings ranging from 6 by 6 ft to 10 by 12 ft, and hole depths from three to nine ft. Blasting ratios varied from 2.76 yd per lb to 11.83 yd per lb, resulting in explosive costs per yd from $0.0281 to $0.0819. In some of these operations the cost of labor is in excess of the cost of explosives used, which accounts for a much greater total cost per yd, ranging from a minimum of $0.0538 to $0.1769.

At one operation, vertical holes are drilled with an auger drill on 14 by 14 ft spacings and ranging in depths from 22 to 30 ft, which rules out any classification as a thin formation. Blasting ratios vary from a minimum of 1.61 yd per lb to a maximum of 2.50 yd per lb, resulting in high unit explosive costs. The low blasting ratios and high unit costs for this operation are shown separately from the other data which has been previously listed, because this is a unique condition where a soft shale is being shot at high cost that could be and is dug quite readily without any shooting at all. This is not intended to present an absurd situation, but rather to illustrate how the overall stripping operation can affect the shooting cost.



The basic principle of the machine to load and tamp horizontal holes is that a tamping pole consisting of six-ft sections, connected by specially designed joints, is pushed in and pulled out of the hole by friction, unwrapping from around a square reel on the instroke and wrapping around the reel on the outstroke. The friction is provided by two pairs of rubber-tired wheels, arranged so that each wheel is driven

At this operation, all of which is deep overburden, a shovel and dragline work in tandem, with the shovel stripping the upper cut to the maximum depth for which it has spoil room. The dragline works on a roadway built on top of the shovel spoil, taking out the lower cut to the coal by digging crosswise the pit, with the bucket loading started at the highwall side. Regardless of how soft the shale is, as long as it has not been disturbed from its original bed, the dragline bucket will only scratch off thin layers and full bucket loading will not be obtained.

To overcome this condition, two rows of holes are drilled on the highwall side of the lower bench down to the coal, and these holes are loaded heavily to produce very small fragmentation together with maximum displacement. This more or less pulverized and churned condition of this area of the overburden allows the bucket to literally drop down through it, and when pulled into digging position by the drag rope, will make a cut of sufficient depth to insure full loads. As previously stated, the shale outside the shot area is easily dug, and it is a fortunate situation that these high unit shooting costs apply to only a small percentage of the total yardage stripped.

Delay Blasting

Two principal reasons for using the delay blasting system are: (1) to substantially reduce the amount of vibration caused by blasting, and (2) by providing maximum relief for every hole fired, produce better fragmentation. In addition to the factor of maximum relief it is a widely accepted theory that the explosives have a two-way chance to produce fragmentation in at least a portion of the overburden.

When an individual shot is detonated, all of the overburden surrounding the hole is immediately put in suspension or under stress, causing fragmentation for at least half the distance to the adjacent hole, providing, of course, that the proper hole spacing has been used. When the second or adjacent shot is fired the explosive force works through the overburden to such an extent that it contacts or enters the overburden being broken by the first shot. With the very short delay periods made possible by modern methods, the explosive force generated by the second shot contacts or enters the overburden which is still in stress from the first shot, which causes even better fragmentation in the overlapping area.

Delay blasting caps were used when the system of delay shooting was first introduced, and are still used almost wholly for the blasting of thin formations with close hole spacings. In a large percentage of conventional overburden blasting, delay blasting caps have been replaced by a combination of detonating fuse and millisecond delays commonly called MS connectors. Delay caps normally are furnished in a small number of series, which means that only a comparatively small number of holes can be fired and be individually delayed.

By using MS connectors in the proper positions in the trunk line or lines connecting the individual holes, an unlimited number of shots can be fired with each shot delayed from every other shot.

The safety factor resulting from the elimination of the use of any blasting caps during the loading and connecting operations until the final moment of firing the shot, and the elimination of blasting caps in any holes which might have misfired, has added to the trend to detonating fuse and MS connectors. The advocates of the use of blasting caps contend that the initial point of detonation should be at the point of maximum confinement, which, of course, is the bottom or back of a shot. No one with any knowledge of explosive theory would dispute this contention. With all the advancement made by the explosives industry, especially in the past few years, the writer does not feel too far out on a limb when predicting that an eventual method will be developed to initiate detonation in detonating fuse at the points of maximum confinement, ruling out the present use of a blasting cap to accomplish this feat.

Loading and Tamping Horizontal Holes

The only remaining operation in the strip mining industry requiring large amounts of manual labor has been converted to a mechanized operation at a southern Indiana mine by installing two machines to load and tamp horizontal holes. These machines were designed and built at the mine and a patent applied for on the original machine. The basic principle of the machine is that a tamping pole consisting of six-ft sections, connected by specially designed joints, is pushed in and pulled out of the hole by friction, unwrapping from around a square reel on the instroke and wrapping around the reel on the outstroke.

The friction is provided by two pairs of rubber-tired wheels, arranged so that each wheel is driven. The stroke is reversed by means of a reversing switch located within easy reach of the shooter standing by the collar of the hole. The amount of friction against the tamping pole can be regulated by an adjustable spring tension system. More friction is required when loading a sticky or dirty hole, or when the tamping pole becomes slick with mud and water.

The first machine was equipped with 2½ in. square wooden poles, but these have all been replaced with poles made from 1¾ by 2¼ in. rectangular aluminum tubing. The original aluminum joints used on the wooden poles are being used on the aluminum poles. These joints are designed to lock together when the pole is in compression to provide the necessary rigidity, and the tension required to pull the pole out of the hole pulls the locking arrangement apart so that the connections become hinged joints and allow the pole to wrap around the square reel, which has side dimensions to accommodate the six-ft pole sections. The tamping head is made of wood, so only wood and a non-sparking metal enter the hole.

The reel used for pole storage is not power driven, but does have a torque motor cable connected to it which provides sufficient strain to cause the reel to wind up the poles on the outstroke. The strain caused by the torque motor is easily overcome by the friction drive on the instroke. The reels in use have storage capacity for 13 sections of pole, making a total pole length of 72 ft. On the average, ten ft of the total pole length will not be usable, but with 60 or 62 ft of effective pole length a 70-ft hole can be easily loaded. By increasing the width of the reel, any number of pole sections required could be added. As the reel winds or unwinds, it is indexed laterally so that the pole is in alignment with the hole on the instroke and the wrapping alignment is correct on the outstroke.

The loading and tamping devices of the first two units put in operation were mounted on sidewall drills from which the drilling mechanisms had been removed. This arrangement allows the utilization of the elevating and tilting mechanisms which are necessary to align the tamping pole with the hole, and provides propulsion for the machine. Tamping machines under construction, as this paper is being written, will be mounted on tractors.

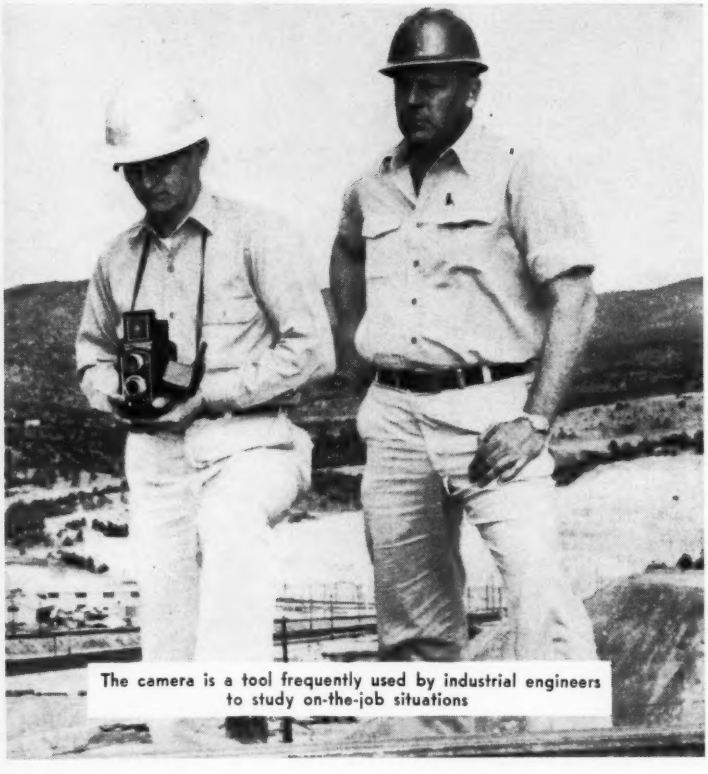
Only one shooter is required to operate each of these machines. After the machine is aligned with the hole, the only work required of the shooter is to place in the collar of the hole the amount of explosives or number of tamping bags to be pushed in the hole for a single stroke. Normally only 100 lb of explosives are pushed in the hole at one time, because it has been proven by experience that less trouble results from using that amount, but in perfectly clean and dry holes the machine can push 200 lb as easily as it does 100 lb. Tamping bags are pushed in the hole, two at a time, and normally a total of eight bags are used.

When the pole reaches the back of the hole with no explosives in front of the tamping head, the friction rollers slip on the poles. When a run of explosives is pushed in the hole, considerable swelling of the bags or cartridges occur before enough resistance is created to cause the rollers to slip. This causes confinement of polyethelene packaged explosives comparable to the confinement obtained when the bags are dropped in vertical holes and squat and swell. While the machine cannot duplicate the time honored method of pounding or hammering the tamping bags with the pole, it can apply enough direct pressure to swell the bags enough to produce very satisfactory confinement.

In actual practice a helper is used whose time is spent mainly in the filling of tamping bags. With the prefilled bags, one shooter has loaded and tamped a maximum of 28 holes in a 7-¼-hour shift, and loads as a consistent average 20 holes per shift in addition to connecting and firing shots as required. The tamping pole travels approximately 120 fpm, which is indicative of the speed with which a hole can be loaded.

"That's One of the New 1958 Models"

ROLE of the INDUSTRIAL ENGINEER in The Mining Industry



The camera is a tool frequently used by industrial engineers to study on-the-job situations

By I. K. HEARN
Chief Industrial Engineer
Western Mining Divisions
Kennecott Copper Corp.

Ever decreasing ore grades and constantly increasing costs have convinced progressive mining companies that, if they are to survive in a highly competitive economy, they must take full advantage of every advance in modern scientific management. The industrial engineer can play a significant role in helping to develop and maintain a healthy domestic mining industry. He not only provides technical proficiency in the use of proven successful cost reduction tools and techniques but, in addition, the industrial engineer is the only member of the management team who can devote his full time and effort to a continuous cost reduction program

FOR at least 20 or 30 years, the minerals industry has realized that the easily won metals are gone—that they had been fading from the scene since shortly after the turn of the century. No longer could a mineral or metal discovery be anticipated through searching for outcrops, with development begun at the grass roots. No longer was handling of high grade ore the rule, because the high grade had petered out.

Grade of Ore Decreasing

Instead of a relatively uncomplicated mining procedure, wherein the principal problem was to meet the payroll and maintain an adequate reserve of ore developed ahead of operations, the mining engineer faced the prospects of lower and lower grade ore and the introduction of mass production methods to combat increasing costs of labor, materials, and transportation.

It was these factors that brought about engineering techniques that set the stage for the appearance of the industrial engineer in the minerals industry. Where once the tools of prospecting were the pick and shovel, there now exist more complicated procedures involving studies of regional geology, geophysical methods, geochemistry, thermodynamics of ore genesis and expensive deep hole drilling.

It was not too long ago that a mine could be developed for an investment of something like $5000 per worker. That day is gone. In its place we see such developments as the San Manual Copper Corp. in Arizona where an expenditure of more than $100 million was required be-

fore any metal was produced; or the Lavendar Pit, also in Arizona, where expenditures of more than $125 million were required before the first ore was treated. If you include the cost of exploration, development, plant and equipment, the cost of creating one new job at these two projects was approximately $50,000 per employe.

The principal reason for this high cost is the fact previously mentioned —the grade of ore processed today is becoming progressively lower. It is interesting to note that the copper recovery per ton of ore treated in the State of Arizona in the decade of 1910 was 48.38 lb per ton. From 1944 to 1955 it was 17½ lb per ton. This diminishing trend applies to other metals as well as to copper.

These examples are cited because they point up dramatically the fact that if the minerals industry is to thrive it must utilize all the techniques at its command. To do otherwise is to court disaster.

During the past few years, there have been an unusually large number of companies combining their interests to develop new properties and processes, particularly with respect to pioneering work in new ventures.

While such partnerships share the financial risk involved, the principal reason for teaming up is to utilize to the fullest extent the research, special skills and know-how each partner can contribute to the eventual success that might not otherwise be achieved had each partner elected to pursue his course alone.

Minerals Industry Finally Accepts Management Aids

It seems to the writer that the handwriting has been on the wall for many years, but the minerals industry, whether hidebound by tradition or just plain loath to keep abreast of the times, has not taken advantage of the aids extended to it.

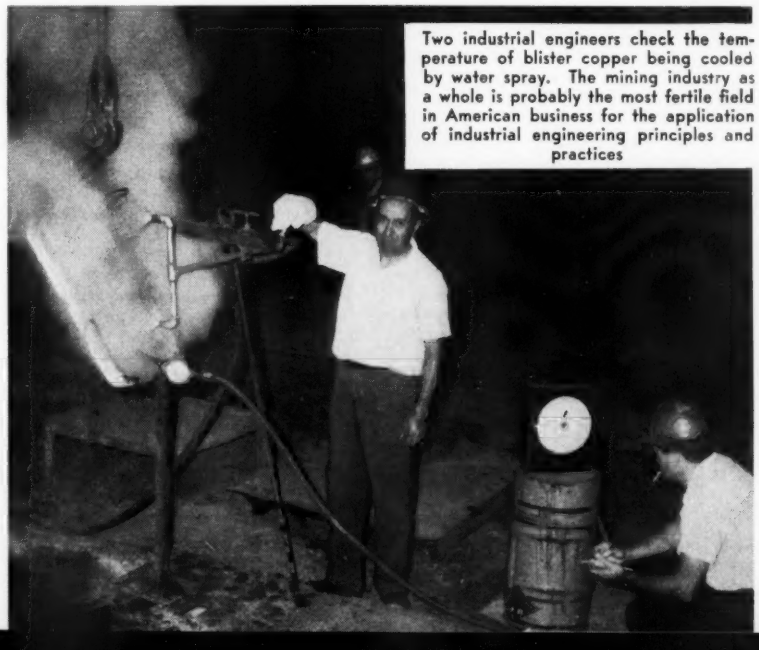
In the past several years the industrial engineers in Kennecott Copper Corporation's four western mining divisions have devoted a large portion of their efforts to methods improvements which have resulted in substantial savings

This is true not only of the basic sciences, but also of the so-called social sciences, such as industrial relations and public relations. Management in manufacturing, for example, has been utilizing these techniques for more than 25 years.

Industrial relations was thrust upon the minerals industry when it dawned on management that it was taking a beating in the treatment and training of its employes and in its labor contract negotiations. Finally, the minerals industry followed the example of manufacturing and other industries and created industrial relations departments.

The minerals industry operated under the theory that all that was necessary to justify its existence was to get out the muck, meet the payroll, and pay the shareholders an annual dividend. Meantime, the industry was learning the hard way that it was making a sorry showing against the slick ideologist, the articulate bureaucrat, or the type of labor leader then coming to the fore, who was armed with every new technique of propaganda. And so, purely in self defense, it adopted public relations in a conscientious effort to tell the public what it was doing and why. While the value of this effort was slow in being recognized, it has now become an accepted management practice.

What is true of these management aids is also true of industrial engineering. The formal acceptance and recognition of industrial engineering was belatedly granted by the minerals industry. (A notable exception to this attitude is found in the mining operations of the steel industry, where industrial engineering procedures have been used for decades.) The reluctance to accept industrial engineering methods was due primarily to the firm conviction in many mining circles that the basic techniques and tools of the profession, such as time studies and incentive applications, could be applied successfully only in repetitive manufacturing processes. It was argued that in mining the basic production tools were highly mobile pieces of equipment, handling a wide variety of ore and waste materials and working with many variable physical conditions. The shovels, drills, trucks and locomotive units were not tied down in orderly production lines, and therefore time studies, standard procedures and standard cost programs were not



Two industrial engineers check the temperature of blister copper being cooled by water spray. The mining industry as a whole is probably the most fertile field in American business for the application of industrial engineering principles and practices

View of a test being run with a machine used to load commercial ammonium nitrate into toe holes for blasting. There is an urgent need for more accurate and detailed quantitative data on the performances of men, materials and equipment

considered applicable to mining. Fortunately, for many mining companies, this attitude has changed radically in the past few years. The ever-decreasing ore grades and ever-increasing costs have convinced the more progressive mining companies that if they are to survive in a highly competitive economy, they must take full advantage of every advancement in modern scientific management.

Kennecott's Experience—Substantial Savings

An increasing number of companies in the minerals industry, particularly the coal operators, have come to realize that they need industrial engineers who can devote their full time in a continuous search for better utilization of men, materials, machines and money. In Kennecott's own organization it has become evident that the open minded analytical approach of industrial engineers can result in the development of improved methods of doing practically all tasks accomplished through human effort.

In the past several years the industrial engineers in our four western mining divisions have devoted a large portion of their efforts to methods improvements which have resulted in substantial savings. This important activity of improving methods and procedures has not been carried on just by industrial engineers. All supervisors have been given basic training in the use of flow diagrams, flow process charts, man and machine charts and the analytical questioning approach. This training materially assists the foremen in developing methods improvements in their areas of responsibility. There have been several advantages of this type of training for the foreman. It has made their jobs easier and saved the company money, and at the same time industrial engineers have been able to devote greater portions of their time to more complex and significant economic studies.

Kennecott's methods improvement program recently received real impetus through the introduction of a suggestion system and patent award program for both day-pay and supervisory employes. The work force of any business, provided there is an added personal incentive, constitutes a tremendous potential reservoir of ideas for improving operations. Who is in a better position than the line operator to realize that long established practices and habits may cause unnecessary delays, breakdowns, poor communications, wasted steps and so forth?

The minerals industry is rapidly discovering that it is imperative to establish complete cost and performance standards on all phases of its operations if it is to be successful in combating rising costs, foreign competition and the substitution of other materials. In the past, like many other industries, the minerals industry was reluctant to reveal its costs to anyone below the level of assistant general manager or superintendent. Today, there is a growing appreciation that it is the front line foreman who is directly affecting most of the costs by the manner in which he uses the labor, materials and equipment for which he is responsible. Therefore, many mining companies are now developing the necessary cost and performance controls and reports which will inform each level of management, including the line foremen, exactly how the actual costs and performance compare with engineered standards established for the work.

The writer doesn't mean to infer that Kennecott has attained complete performance and cost controls, but the industrial engineers are spending an increasing portion of their time in developing these improved control procedures. Initially, the corporation is using temporary cost and performance standards, based primarily on historical data, but completely engineered standards will be developed as quickly as possible.

Some Industrial Engineering Functions

Industrial engineers have played an important role in assisting the industry to develop sound wage and salary programs, although the use of job descriptions, job evaluations, performance appraisals, area surveys and other related tools so widely accepted by government, manufacturing companies and large service organizations is still relatively new in the mining industry.

It has been estimated that one-half of the annual gain in productivity comes from better organization and one-half from better technology. If this is true, the time and effort spent in improving management communication through a more effective organizational structure is obviously an area of critical importance in any industry. Industrial engineers are making a significant contribution in the minerals industry by assisting management in the development of improved organization structures, which permit clear definition of functional lines of responsibility, eliminate overlapping duties or authority, avoid surplus or ineffective levels of supervision, establish optimum spans of control, and provide an engineered balance between the labor force and the work requirements in all levels of responsibility.

The increasing complexity, scope and cost of mining operations require more formal justification and control over expenditures, particularly with reference to capital expenditures. In many mining companies, the industrial engineers now work closely with the various operating and staff departments in developing and correlating all necessary data required to justify requests for capital appropriations.

Still Much to Be Done

Some of the industrial engineering functions, which are currently being utilized by a limited number of the more progressive mining companies, have been mentioned. However, despite the progress to date, there is still much to be done. The mining industry as a whole is probably the most fertile field in American busi-

After graduation from Virginia Polytechnic Institute in 1937, I. K. Hearn progressed through various supervisory positions with Tennessee Coal & Iron Division of United States Steel, including operations engineer. Following five years' service with the Corps of Engineers during World War II, he organized and directed the initial Industrial Engineering Department of the Ore Mines and Quarry Division of T.C.I. Since 1949 Hearn has served in various senior staff positions with Kennecott Copper Corp.

ness for the application of industrial engineering principles and practices. There is an urgent need for more accurate and detailed quantitative data on the performances of men, materials and equipment. Work sampling, time studies, standard data and statistical methods are furnishing valuable information to management, but the surface has hardly been scratched.

The mining industry, without a doubt, has the largest materials handling problem in the world today, and yet consider how little imagination and real analytical engineering has been devoted to this problem. The wagons and the hand shovels have been replaced by large mechanical units. But there are very few mining companies that have made a complete analysis of their drilling, blasting, loading, haulage, milling, smelting and refining operations so as to determine for each ton of material the optimum combination of material handling techniques and equipment.

During recent years several mining companies, including Hollinger Consolidated Gold Mines Ltd., in Canada, have attempted to control spiraling costs and to increase productivity through the development of direct financial incentive applications for hourly employes. Such incentive applications are based on measured work standards developed by accepted industrial engineering techniques and procedures. No doubt the development of incentive applications based on measured work standards will receive increased consideration and attention by the minerals industry in the future.

The minerals industry does not have to cope with extremely short cycle, repetitive operations requiring micro-motion standard data systems or photographic work measurements. Nor does the raw materials producer require elaborate electronic computer installations to control nation-wide distribution of products, or to control extensive inventories of spare parts. However, in those mining companies having decentralized operating divisions spread over wide geographical areas, the use of electronic computers for centralized processing of cost and performance data offers attractive possibilities. Such installations could decrease clerical overhead costs and provide prompt, effective distribution of timely cost data to all levels of management.

New Approach Needed

The basic approach to mining has changed very little since the days of the early Phoenicians. We still make little rocks out of big ones, separate out part of the waste material and subject the remainder to heat or chemical reaction in order to obtain a commercial product.

The minerals industry needs a completely new approach to its ancient methods and practices. It needs the services of integrated teams which combine the know-how of all engineering and research arts. Such teams should include industrial, mechanical, electrical, metallurgical and chemical engineers, together with various research specialists. Such teams would make comprehensive and imaginative investigations of every fundamental facet of our business.

In view of the forward strides made in the past few years, it is conceivable that by the use of integrated technical teams the industry should eventually develop new applications of chemicals, electronics, heat, pressure, etc., which could in turn revolutionize present mining, milling, smelting and refining practices. Two examples of practical developments along this line of thinking would include gasification of coal mines in the east and the pressure-leach precipitation methods practiced by the Calera Mining Co. near Garfield, Utah.

Continuous Cost Reduction Program

A strong and healthy minerals industry is of vital importance to the entire nation. The writer suggests that in turn the minerals industry has a fundamental responsibility to demonstrate to its stockholders and the communities in its areas of operations, as well as the American public, that it is doing everything possible to make maximum effective use of its men, materials and machines, in order to minimize costs and meet foreign competition successfully.

The industrial engineer can play a significant role in helping to develop and maintain a healthy domestic mining industry. He not only provides technical proficiency in the use of proven successful cost reduction tools and techniques but, in addition, the industrial engineer is the only member of the management team who can devote his full time and effort in support of a continuous cost reduction program.

All too frequently, industry is guilty of initiating spasmodic, intermittent cost reduction campaigns, conducted on a crash program basis and generally brought on by fluctuating market conditions. Such an approach may provide some measure of temporary success, but in the long run it is not nearly as effective as a planned, continuing program of cost reduction.

Typical facets of a continuing cost reduction program are:

(1) Development of an effective organizational structure.
(2) A planned systematic program of methods improvement studies.
(3) The provision of cost and performance information to front line foremen.
(4) Establishment of standard operating practices and procedures.
(5) Development of measured work standards for all phases of the operations.
(6) The development of an effective preventive maintenance program.
(7) Development of wage incentive applications.
(8) The development of standards and quality controls.
(9) Improvements in plant layout.
(10) Development of standard costs throughout the operations.
(11) Justification of capital expenditures.
(12) Classification of all production and maintenance jobs.
(13) Evaluation of salaried positions.

This is but a brief listing of the many cost reduction activities which the industrial engineer is trained to plan, develop and install as effective tools for the minerals industry. These are not impractical or theoretical visions, but applications of scientific management principles and practices which have proven effective and successful for several decades in American industry.

Human Relations Important

Industrial engineering involves the design, improvement and installation of integrated systems of men, materials and equipment, and the evaluation of the results to be obtained from such systems. However, no branch of the engineering profession is more dependent upon the development of good human relations for the successful accomplishment of its objectives. No method, or system, is worth the price of a pound of zinc or copper, unless the foreman and his men participate in its formulation and support its application. The continued practice and growth of this basic philosophy will undoubtedly be one of the most important elements in the industrial engineer's future efforts to help build and maintain a strong and healthy minerals industry.

In conclusion, the writer would like to quote the comments of Mr. Harlow Curtice, president of General Motors, regarding a basic fundamental of business that applies equally to all levels of the management team—"No war, no depression, no strike can so quickly and irrevocably destroy an established business as better methods in the hands of an enlightened competitor."

TRENDS in Coal Preparation

The ultimate in plant design and construction has never been reached and never will be as long as research and engineering continue their advance

By JACK M. BISHOP
Chief Chemist
Truax-Traer Coal Co.

THE ultimate in coal preparation is to reduce the ROM feed to its basic constituents for re-assembly in the product to conform to market demand of locale or industry. The amount of preparation necessary is dictated by the market to be supplied and the realization possible from this market.

Central cleaning plants have long been argued pro and con. One of the greatest advantages for this concept has been the advance of blending bins for upgrading of coals and the elimination of destination blending by consumer. At the Ceredo plant of Truax-Traer Coal Co. such a bin is now a reality. A blending bin at a central cleaning plant utilizes to the utmost the output of several low volume mines. Location of the central plant on an inland waterway again increases the plant's versatility and possible access to markets at favorable freight rates.

The modern coal cleaning plant is a product of imaginative science brought to a real and worthwhile use in this present day's trend to a specialized fuel for special uses. A progressive operator using the latest techniques has a better chance to exploit his product to the fullest. Formulae, techniques, phraseology that are in every day use today were the exception of a few years ago. Using as examples of the foregoing, we note: "Free Swelling Index" or the more popular FSI, the newer "plasticity tests," the increasing use of "Grindabilities," "Fusion Tests," and "Ultimate Analyses."

Consumers have become more aware of modified coal and special stoker sizes. Correct blending in exacting proportions of various seams to underplay their shortcomings, if any, and bring to the fore their more saleable advantageous points has become commonplace. Seams that were once considered not acceptable for the specialized metallurgical coal of today, due primarily to improved tipple design and equipment and personnel know-how, are now prime "met" coals and perfectly acceptable in making coke.

Objectives of Coal Preparation

The basic concept of a plant is to clean, dry, crush, blend, size and convey in volume the finished product. A plant so designed will help to minimize the operator's economic problem, even in the increased cost of present-day production. The length of life of the plant is a split responsibility by the coal company and the design engineer. Management predetermines: (1) seam to be mined, (2) approximate tonnage to be moved per year, (3) acreage available, (4) market to be supplied. Design engineers supply for approval design prints covering installation, preparation, equipment, projected room for alteration in event of market instability, consumer demand or business needs.

The ultimate in plant design and construction has never been reached and will continue to present an ever-rising mesa as long as research and engineering continue their advance.

Ascending labor costs dictate a type of push-button control in future designing. Examples of this may be found in increased use of central greasing of units; "tattle-tale" lights, horns, etc., in signaling approaching or current difficulties; automatic controls—both starting and stopping of units to perform a given operation without personnel supervision.

In the past several years multiple crushing has increased in popularity. This is due primarily to market indifference to carbon or fines. When a single crusher is set to produce a given top size, let us say 1½-in., from a feed of five-six in. top size, the 1½-in. resultant has an abnormal percentage of fines. However, in series crushing where more than one crusher is used, the produced carbon from the resultant is materially lessened. Market indifference to carbon is reflected in less realization per ton sold. While some consumers have no objection to a coal having a large percentage of fines, other consumers request guarantees as to the amount of fines.

It is true that in many instances the fine coal has an analysis as equally acceptable as the coarse coal, but due to the particle size and the surface area involved, more moisture is retained with a consequent reduction in "As Received" values. Other points for consideration would be absorption of moisture in stock piles and windage loss in loading or unloading or in stock piles. Where a coal must be handled two or more times, the degradation increases with each handling; therefore, the customer takes the easiest way out and demands a coarser coal loaded initially to insure a minimum amount of carbon at final destination. Series crushing multiplies initial installation cost but is returned to the operator in higher realization per ton produced.

Protection Against Freezing in Shipment

Winter weather with lower temperatures gives the coal industry a "shot-in-the-arm" in providing an increased demand for our product. It also brings added problems in processing. In some mines, due to poor roof conditions or low cover, or both, the produced ROM is wet. If that raw coal is loaded in railroad cars for processing at a tipple some distance away, difficulty in unloading cars can be expected. This difficulty can be eliminated in part by use of a rotary dump equipped with vibrators. Such an installation allows easy access inside the car to free frozen coal in hoppers or slope sheets that are the most likely points to freeze.

Another proven method of overcoming this freezing problem is to oil the inside of the railroad car prior to loading. Quantity of oil used is 6.0 to 7.6 gal per car, depending on its size. Specifications of oil used are low viscosity, free-flowing and a pour point of minus 20° F. The oil is applied through a flexible hose under pressure and through a short length of pipe equipped with a quick-acting nozzle. Approximately 20 seconds is required per coal car and cost is approximately one cent per ton. TPH unloading at destination has been increased due to this method.

Addition of heat to railroad cars before unloading has been a common practice—either from a heating pit below the car or from a shed surrounding one or more cars. The combination of oiling cars before loading and the addition of heat be-

fore dumping reduces the unloading problem. In years past a salt brine has been added to certain coals to freeze-proof prior to or during loading. Both liquid and flake salt is used. This past winter season is the second for our company to replace this brine with oil. Consumer acceptance has been most gratifying to this new treatment. The same oil can be used in treating cars, thus eliminating storage and supply problems if two oils were necessary.

Thermally dried fines have eliminated much of the freezing problems. The application of heated wash-water, where excess heat is available at little or no extra cost has had a limited success. As the wash-water temperature is lowered in winter weather, a consequent increase in moisture is noticed. This is probably due to increased surface tension of the water. Those of us who have washed dishes know that a dish rinsed in hot water will dry more quickly than one rinsed in cold water. This is relatively the same principle. The addition of latent heat, however small, to the coal will help dewater and thus reduce the unloading problem.

Automatic Sampling Replaces Hand Sampling

Added emphasis in recent years has been placed on correct standardized procedures in taking, preparation and analysis of samples for chemical analysis. The old "grab" sample of one increment as a final word has been replaced by the multiple increment composite sample. The manually taken sample has been replaced with automatic samplers eliminating the ever-current personnel error and insuring a true picture of plant efficiency and product.

Many plants in existence today were not designed for adequate sampling points. As the need arises for true samples at given locations, additional cost is added to production to provide these points. Automatic samplers should be so designed to give full stream "cutting" and insuring proportionate parts of each size fraction loaded. Adequate riffling, crushing and conveying are added points for consideration.

At the Ceredo plant the sampling is set up on a timed 30 minute composite basis taken by an automatic sampler. Approximately ten percent of the total volume of coal is sampled and through crushing and riffling is reduced in volume to about 150 lb of about 20-mesh coal. This sample is again riffled, with portions saved for ash and moisture determinations. With certain modifications of the approved ASTM methods, the tipple foreman is advised of the ash analysis within 30 minutes after the coal is loaded in either railroad cars or barge. Later the analysis is reported on ASTM standards. At the end of that particular run of coal, a complete Proximate Analysis is made on the composite of all samples.

Communication in the modern plant is speeded up with inter-coms and telephones placed in strategic locations. Closed circuit televisions can now be a reality. A centrally located operator can personally oversee several operations at once.

ADVANCES IN OFF-HIGHWAY TRUCK DESIGN

(Continued from page 37)

and converter lockout are left to the discretion of the operator. We are at present field testing this converter in a single axle 35-ton truck behind a 400-hp engine. In this application, and mounted midship to the converter, is the first three-speed mechanical transmission capable of transmitting up to 600 hp.

To meet the specific demands of short hauls, adverse grades, and constant climbing and descending, a model is available designed almost entirely away from the human element of the driver. Where there is no need for converter lockout, a conventional clutch, three-stage converter, and midship mounted three-speed mechanical transmission with automatic engine braking is available for horsepower requirements up to 500. Since 1951, this converter package has been most instrumental in the advance to utilize converter characteristics to minimize the two worst enemies of the Diesel engine, lugging and overspeeding, as well as absorb shock loads and torsional vibration.

In general, the converter-transmission picture indicates higher horsepower capacities, versatility of installation for any given engine and operating condition, converter lockout, and engine braking.

Off-Highway Truck Tires. The need for larger high pressure tires capable of carrying bigger loads, and further, additional durability to withstand the cutting, snagging, and abrasion was pointed out very early in the evolution of the off-highway truck. Necessity promoted the development of the "rock service" lug design for the industry. Tire carcass strengths have been increased considerably with additional plies and breakers and the introduction of better material for the cord body of the tire. The cotton tire, on the first 15-ton trucks, was replaced by the rayon tire in the early 1949's for the 22-ton truck. In the late 1940's the first nylon tires were put out for field testing. To resist tire bruising, the design trend of tire construction has been towards a stronger and lighter carcass, which has been accomplished, in part, with the nylon construction. The resistance of the nylon carcass to separation when exposed from cutting is good because it will not wick moisture, and the additional carcass strength has promoted several recaps.

Where tires were originally equipped with tube and flap, they are more recently being replaced with the tubeless tire. Some of the advantages of the tubeless type are the elimination of tube and flap troubles, expensive tube replacement, and a cooler operating tire due to a reduction in weight. Mounting and dismounting, with the proper tools, is easier and faster where the tube and flap are eliminated and where double inflation is not required. The acceptance of the tubeless tires on the Mesabi Range has been retarded by those problems brought out by field testing with both the tire and rim. Further, the advent of the more recent high profile or super tire with tube and flap has slowed down the move to tubeless tires. To resist road abrasion, the high profile, with built-in cap, has been brought into the picture with a 60-90 percent increase in "non-skid" on the tire, but is not, as yet, a tire and rim standard.

The future in tire thinking will promote the development of super nylon tires for extended carcass life and further reduction in weight. Where both the tubeless and high profile tires are now in their initial stages, field tests are being conducted with the combination tubeless high profile tire. For further protection of the carcass, and cooling, the use of steel carcasses and variations will be developed. To combat the more recent heat problem encountered in high speed long haul operations, tire manufacturers are working on a semi-highway tire designed to dissipate the heat, and for rock service, which will undoubtedly introduce a new "load table" for this service.

Conclusion

A thorough analysis of the job requirements, inherent to each individual operation, is probably the most important factor which will enable the operator to utilize the advances in off-highway truck design. With the wide variety of truck capacities, types, power train packages, tires, etc. available today, coupled with our past experience, the operator is in a much better position to select that haulage unit most applicable to his job.

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PATTERN CUTTING—*only Lee-Norse has it.*

CUTS MORE COAL WITH LESS POWER . . . *cutters revolve and oscillate at the same time—milling the coal from the face.*

CUTS A COARSE PRODUCT—FEWER FINES . . . *cutter bits follow a right and left spiral direction producing a diamond pattern which breaks off in coarse cuttings.*

A SIMPLE, STURDY MACHINE . . . *essentially a modern loading machine on which is mounted a set of efficient cutting heads.*

HIGHLY MANEUVERABLE—FAST TRAMMING. . . *not a "muscle-bound giant" . . . it quickly follows any variation in seam thickness.*

EXCELLENT CLEAN-UP . . . *improved dual gathering arms load all the coal into a flexible rear conveyor.*

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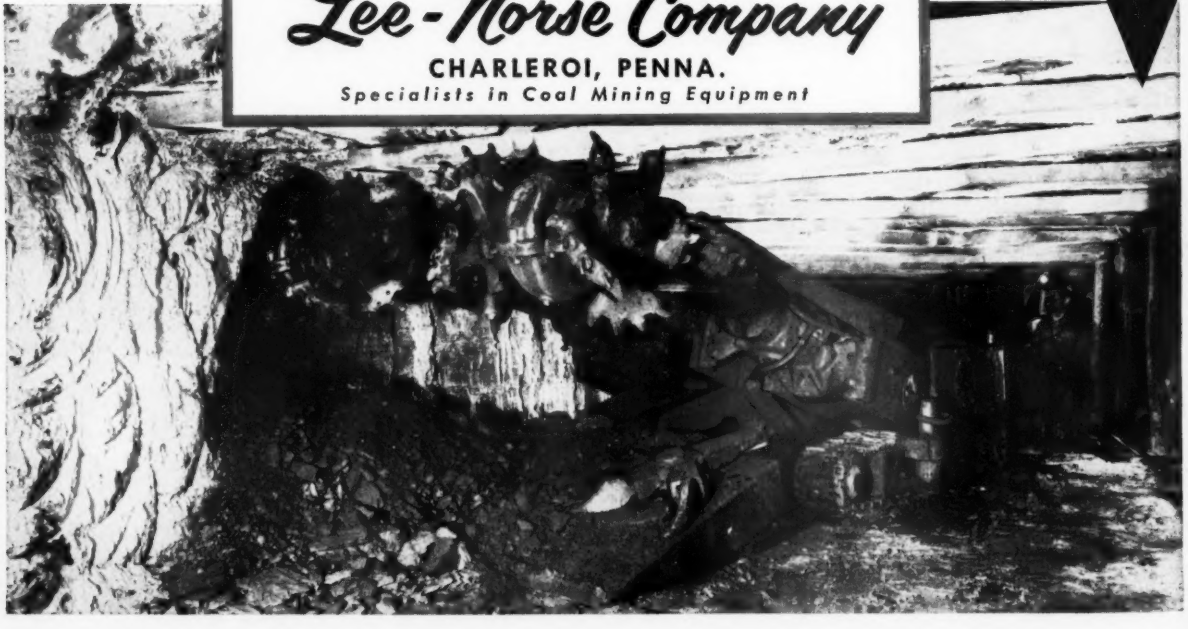


Research in the DIRECT REDUCTION of Iron Ore

The next decade should produce some interesting developments in processes for direct reduction of iron ore. The high quality of the work done to date, as reviewed herein, and the costly programs supported by large steel companies lead to the prediction that commercial applications will soon appear—opening doors to more economical use of ores and fuels

By H. S. TURNER
Vice-President-
Research & Development
Jones & Laughlin Steel Corp.

THE elimination of oxygen from iron ore is generally a heat absorbing reaction. This is a fortunate circumstance for there has been plenty of heat generated in the arguments about the failure of direct reduction processes over the years. While this particular heat may handicap the modern technologists who are now studying reduction, significant advances have been made through their vigorous efforts of the past decade. There is general agreement that the quality of their efforts is substantially above that which supported the literally hundreds of investigations of prior years, both crackpot and otherwise.

An examination of a large number of these earlier efforts reveals only limited use of kinetic and thermodynamic principles; of the controlling factors of heat and mass transfer; and of the influence of equipment on the efficiency of gas/solids contacting. This stands in sharp contrast with the modern methodologies employed by the trained process engineer and his associates who today are using these tools effectively in the analysis and process developments of direct reduction.

In this discussion, no attempt is made to reach economic conclusions, but rather the object is to review currently available information on research and development in the field of direct reduction, and to classify that knowledge. Several groups doing excellent work today have not yet revealed process details or published their results, but it would be completely unjustified to assume that their contributions to the fund of knowledge in this field and to specific process concepts are of any less value than those which have already been made available by other investigators. Therefore, much must remain conjecture at this time, pending authoritative release of information; but one can make no mistake in concluding

that a great deal of broad importance to the steel industry will be appearing in the next few years in the form of fully developed and soundly based processes for direct reduction.

Several methods of classification of direct reduction processes are possible. All of them depend upon the factors of serious process and economic significance. We may classify processes by the method of gas/solids contacting; by the type of reductant used; by the requirement for carbon as against natural gas as a source of fuel; by the method of putting in process heat; and by the size consist or chemical analysis of the feeds that can be utilized.

The first of these, namely, methods of gas/solids contacting, serves as the principal basis of comment in this paper.

Three Principles of Gas/Solids Contacting

The earliest recorded efforts to make sponge or direct iron involved heating intimate or gross mixtures of iron ore and coal for extended periods. Generally, the only differential movement of the reducing gases and the ore resulted from the gasification reaction that proceeded *in situ*. To a considerable extent, this simple principle has been and may still be employed at Höganäs, Sweden, in making sponge iron. Obviously, the more elegant factors of process design did not disturb the early conceptions of this process.

Systems that do provide for differential movement of solids and gases are well known in vertical shafts and rotary kilns. For direct reduction, these principles are progressively applied: (1) in the Madaras process that operates batch with respect to solids and continuous with respect to gas; (2) in the Wiberg process that is continuous in both respects; and (3) in the two rotary kiln processes, Krupp Renn and R-N. Other systems are designed around differential movement of gas and ore pellets as the pellets are carried horizontally.

Less well known to the ore industry are systems employing the fluidized solids technique. By common consent, this technique can provide the ultimate in gas/solids contacting.

Description of Processes

Before following this theme in greater detail, it is important not to imply that gas/solids contacting is the only criterion of a successful direct reduction process. Practical conditions to be met by such a process include numerous factors that go beyond gas/solids mixing, and the ultimate evaluation of any given reduction process is a most complicated matter. Other factors to be weighed include methods of getting process heat into the reducer; steps required for efficient use of the reductant; the obtaining of a product acceptable in size and composition for subsequent steelmaking; and finally, the ability of the process to handle various ores in a practical and economical fashion.

The R-N processes had its origins in early work by National Lead Co. on titaniferous ores in Norway, followed by intermediate scale studies in Brooklyn, and in this pilot plant in Alabama

Returning to the analysis of processes by gas/solids contacting, your attention is drawn first to **the Madaras process.** Over thirty years ago, Julius Madaras began his long development of a process that is currently represented by a 10-ton batch pilot plant at Longview, Tex. In the process, a predominantly 2-in. by ⅛-in. size iron ore is treated batchwise in a refractory-lined, cylindrical pressure vessel with carbon monoxide and hydrogen at 1600 to 1900° F. The optimum temperature varies with the ore. Ore fines, when pelletized, have been fed with the naturally coarse fraction to the reactor.

The reducing gas is made externally by catalytic steam reforming of natural gas and is recycled in the latter part of the process period when reduction is well advanced and conversion of the reductant per pass is lowered. The ore is preheated by passing products of combustion from a dutch oven directly through the charge, and subsequent needs for heat are provided by preheat of the reducing gas. Madaras has stated that a pulsating pressure, maintained in the reactor at about 25 psig, enhances the gas/solids contacting.

The Wiberg process in a refractory-lined, shaft furnace treats a downwardly moving column of coarse ore, or preferably sinter, with an upwardly rising stream of carbon monoxide at 1800 to 1900° F. A portion of the gas is burned in the top of the bed to preheat the ore, and the balance is recycled through a fixed bed of electrically heated, hot coke. This converts carbon dioxide and water into carbon monoxide and hydrogen for fresh reaction with the ore.

Under the economic conditions of Sweden, the Wiberg process is apparently economic. Gas/solids contacting and thermal efficiency (judged by waste gas analysis) are apparently good, but dependence of the process on cheap power, coarse coke, and sinter severely limits its ability to compete in the United States with other processes that are free of these limitations.

An old system of gas/solids contacting operated with new knowledge is found in current developments using rotary kilns. Such a system is employed by the well established **Krupp Renn process.** In the United States, this process is represented by the Southwestern Engineering Company. Krupp Renn plants are currently operating in West Germany, Spain, Greece, East Germany, Czechoslovakia, and Japan. Seven more kilns are under construction for German plants and one for Spain.

In recent years, Krupp is said to have paid special attention to improving temperature gradients and control. As a result, Krupp has reportedly overcome the long-standing criticism of this process which centered on the tendency to build up deposits on the interior of the kiln in the higher temperature zones. The process operates with solid fuel, such as coke breeze or char, ¼ by 0-in. ore, and small amounts of limestone. Gas and solids flow counter-currently through the kiln exposed to a temperature profile that provides 1100° F for the preheat zone, 2000° F for reduction, and 2300 to 2800° F for selective agglomeration of the slag and iron particles as the solids are discharged for quenching. The characteristic lump product of this process is further refined by crushing, which separates the more friable slag. The finer iron particles are concentrated over a magnetic drum.

For controlling the process, an additional heating system is required, operating on pulverized coal or fuel oil. But the reduction itself is accomplished based on carbon monoxide derived from the coke breeze, anthracite, or low temperature coke added with the ore. Thus, availability of a solid carbonized fuel or its equivalent

in composition is an essential to the satisfactory operation of this process.

Chemically, the process has both advantages and disadvantages. Its advantage lies in the fact that at its operating temperature, iron silicates may be brought into reaction, whereas this type of ore passes through without reaction in most of the lower temperature processes. Ability to process these silicate ores makes possible consideration of common iron minerals never before seriously considered as possible sources of commercial iron. The disadvantage, chemically, is that at the same temperature levels sulphur present in the fuel is carried into the iron. A physical advantage of the higher temperature operation is the recovery of the product in a sufficiently coarse form for some direct uses.

On August 1, 1957, Republic Steel and National Lead jointly announced the R-N Corp., formed to exploit the process carrying the same name. **The R-N process** has been studied on a 175-tpd pilot plant scale near Birmingham, Ala., over two years. Some 50,000 tons of metal product have been produced in this plant. No other process, except the Krupp Renn, or possibly Wiberg, has been so extensively tested on so large a scale.

This development had its origins in early work conducted by National Lead on titaniferous ores in Norway, followed by intermediate scale studies on iron ore in Brooklyn, and in the pilot plant at Birmingham. While this process has been evolved through concepts wholly independent of Krupp Renn, it has some similarities. A rotary kiln is employed to secure the desired gas/solids contacting, and coke breeze, used as the reductant, is added with the ore, together with selected amounts of limestone. Process heat is provided by a burner directed into the kiln at the solids exit, and by controlled oxidation within the kiln. Since it operates at a lower temperature than the Krupp Renn process, the R-N product is not agglomerated in the kiln. The reduction step is followed by wet grinding and magnetic separation to free and concentrate the metallic iron, which is then briquetted. By virtue of these steps of concentrating and compacting, the R-N process makes possible treatment of a wide variety of ores, converted to a product of almost any desired iron concentration and physical shape.

As a further result of the lower operating temperatures employed versus Krupp Renn, it is claimed that the R-N process actually removes sulphur and phosphorous from the ores and thereby minimizes this burden on the subsequent steelmaking step.

Without specific data, no detailed comparison between the two processes can be made as to the efficiency of gas/solids contacting, but kiln action in this regard is generally conceded to be good.

Neither process requires a coarse ore feed and therefore this specification, characteristic of ore for the blast furnace, is eliminated. This becomes of increasing importance as experience reveals the appreciable natural fines content of large ore reserves in Venezuela and Canada.

"Built-in" Fuel Added to Pellets

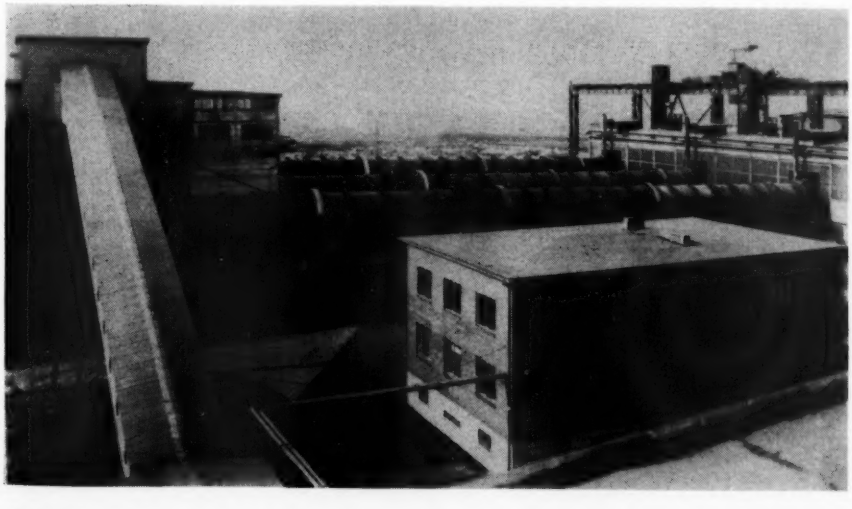
Special problems have been presented in applying the concept of direct reduction to the ever-increasing quantities of finely divided iron ore concentrates derived from lean ores. However, it now appears that at least one solution may be presented by capitalizing on the methods evolved for agglomerating these concentrates to make them acceptable for blast furnace use. Considerable success has been enjoyed in balling these concentrates in rotating drums or discs, followed by firing on traveling grate, in vertical shafts, or in rotary kilns. It was only a step to adjust firing conditions to provide for reduction of these pellets, and investigations along these lines are proceeding in competent hands by at least two companies. There are several variations of this general process scheme, which employ external fuel (principally oil or gas) to introduce the fuel within the pellet, or use coal in the balling unit. For as Professor E. C. Wright, Head of the Department of Metallurgical Engineering, University of Alabama, has said: "Several engineers have found that additions of coal approaching 25 percent of the pellet weight will not only develop a hard, strong pellet, but also pre-reduce much of the iron oxide. . . ." Such systems represent an advance in gas/solids contacting and permit operation at temperatures above that at which discrete small particles of ore and reduced iron would agglomerate, with disastrous effect on operability.

The Fluidized Solids Technique

Now we turn to three other developments, none of which has its origin in the iron ore industry, but which together, have made it possible to exploit what seems to be the ultimate in systems for efficient gas/solids contacting.

These developments are the availability of cheap tonnage oxygen, its use to produce hydrogen via the partial combustion of natural gas or oil, and the development of the fluidized solids technique itself.

The credit for tonnage oxygen should be given to Linde Frankl in Germany. This company set the example in process and industrial development that has been so success-



Reduction in the Krupp Renn process is accomplished by carbon monoxide derived from the coke breeze, anthracite, or low temperature coke added with the ore. Pictured is an installation in Germany

fully exploited here following World War II. With the availability of cheap oxygen, the Texas Co., Hydrocarbon Research, Inc., and the Stanolind Oil and Gas Co. (now renamed: Pan American Petroleum Corp.) each developed the equipment for burning natural gas or oil under pressure with oxygen to produce carbon monoxide and hydrogen. By the conventional water gas shift reaction, the carbon monoxide was eliminated as carbon dioxide, with concurrent formation of more hydrogen. By this method, hydrogen has been produced for most of the synthetic ammonia plants built in recent years. So for the first time, a source of tonnage hydrogen could be considered for reduction of iron ore. The simplicity of this reaction, yielding nothing but metallic iron and water, is obvious.

The original use of the fluidized solids technique for chemical reactions between solids and gases was by Fritz Winkler in Germany. By 1930 Winkler was operating a 10-ft diameter vessel for the gasification of coal in which air passed upwardly in intimate contact with the coal particles. The size of the coal particles and the velocity of the air were such as to maintain the coal particles in a turbulent condition, but not to blow them out of the seemingly fluid bed that was formed. Application of the fluidized solid technique in this country moved forward rapidly as several petroleum and refinery construction companies exploited its possibilities as a means of handling catalyst for the catalytic cracking of heavier petroleum fractions into products of gasoline quality. The growth of the catalytic cracker employing the fluidized solids technique was phenomenal, and today it is not uncommon to see fluidized beds of catalyst up to 40 ft in diameter.

During the 1940's, some of these same companies began to exploit the possibilities of applying the fluidized solids principle in handling iron catalyst for producing synthetic hydrocarbons from mixtures of carbon monoxide and hydrogen by the Fischer Tropsch process. These companies included Esso Research and Engineering, Standard Oil Co. of Indiana, Pan American Petroleum Corp., Texas Co., and others. Engineering construction companies participating in this program included the M. W. Kellogg Co. and Hydrocarbon Research, Inc.

Prospects in a Synthesis of Several New Developments

The technique for producing the finely divided iron catalyst for this synthesis step involved first subjecting magnetite ore or mill scale to fluidization with hydrogen. Heat was carried into the reaction zone by the reductant gas. A vast background of knowledge on the fluidized reduction of iron ore was gained with the object of producing a catalyst, rather than the tonnage objective of producing iron for steelmaking. Among others, H. A. Brassert, W. K. Lewis, and individuals in the Bureau of Mines foresaw this latter potentiality. Substantial programs toward this objective have been carried forward by Hydrocarbon Research, Inc., together with Bethlehem Steel, and by the United States Steel Corp. Arthur D. Little, Inc., has investigated process concepts that originated with W. K. Lewis at M.I.T. when sponsored by Esso Research and Engineering.

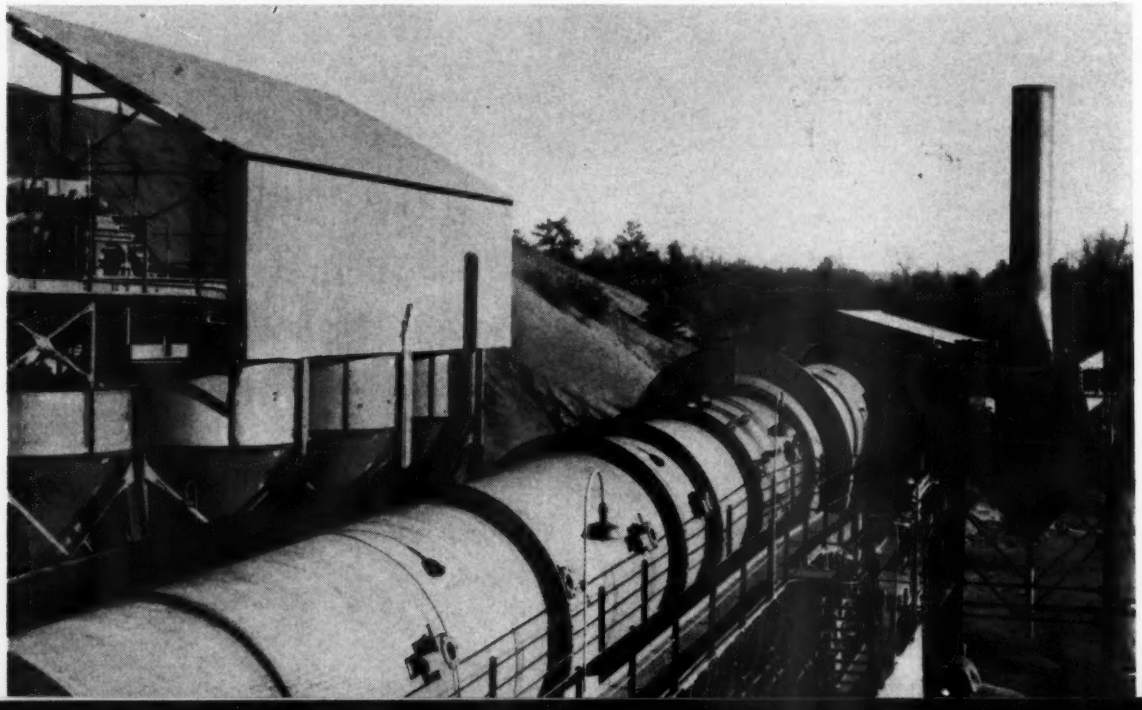
As these major efforts to evolve the tonnage reduction of iron ore got under way, it was apparent that there lay in prospect a fortuitous synthesis of these several developments that were the fruits of investigations undertaken far from specific steel industry objectives. These developments were: tonnage oxygen and hydrogen, the fluidized solids technique, and even the actual fluidized reduction of iron oxides for catalyst production.

Only Hydrocarbon Research, Inc. (H.R.I.) has made public details of its process*, but in general outline, all three of these process developments follow the pattern of introducing a reducing gas to fluidize a bed of iron ore. The finely divided ore is supplied in batch or continuous fashion to the reactor. Optimum size ranges are believed to be slightly different for each process. It is known that hydrogen is used by HRI and probably used by U. S. Steel. Under the W. K. Lewis patent, Arthur D. Little proposes to produce its reducing gas by partial combustion of methane within the bed with air, thus making this heat of reaction directly available for the reduction step. The other processes develop process heat external to the reactor.

The published HRI design provides for a 900 to 1000° F reaction temperature achieved by preheating the ore and the hydrogen gas. In the pilot plant at Trenton, N. J., the reaction

* Journal of Metals, April 1957, "The H-Iron Process" by Squires and Johnson.

The R-N pilot plant in Birmingham, Ala., has produced some 50,000 tons of metal over a two-year period. Rated capacity is 175 tpd



is carried out in a 3-ft diameter reactor in 5-ton batches at 250-400 psig; 400 psig is envisioned in a commercial reactor. The effluent gas is recycled through a heat exchanger and scrubber to remove the water produced by the reduction reaction, and, with makeup hydrogen, is reheated and returned to the reactor. A small purge keeps the inert gas content at a low level. Reduction is completed in 8 to 12 hours, depending on the 75 to 95 percent degree of reduction desired. The product is then compacted into briquettes and heated at a sufficiently high temperature to destroy its tendency to reoxidize with accompanying heat effects.

The reduction reaction conditions used by HRI at Trenton are somewhat higher in temperature and pressure than those currently employed in a larger diameter reactor by the Pan American Petroleum Corp. to produce iron catalyst at their Brownsville, Tex., plant. This company has an extensive background of knowledge in the complex factors that influence reaction rates, gas/solids contact efficiency and entrainment of solids from the bed.

It is generally believed that the U. S. Steel and Arthur D. Little processes operate at higher bed temperatures and lower pressures as compared with HRI. This results in significant changes in heat balance and incentive for gas recycle. Since neither U. S. Steel nor Arthur D. Little has issued process details, these several fluidization processes cannot be directly compared.

It is apparent that the process principles employed in these fluidization processes fit extremely well into the use of ores and concentrates that are naturally fine, since only moderate grinding of coarse fractions is required to reach a satisfactory size for fluidized reduction. This stands in contrast to the sintering required to prepare the same raw materials for the blast furnace. Furthermore, elimination of any need for coal of any grade removes a limitation associated with several other processes described in this paper.

Under no circumstances should these observations be taken as proof of economic superiority, however. The facts are simply not yet in to reach such a conclusion. However well the economics of the fluidized reduction of iron ore may ultimately stack up versus other equally well engineered process designs, one cannot escape feeling the excitement that this entirely new system brings to the long-standing traditions and concepts of solids handling characteristic of the iron and steel industry.

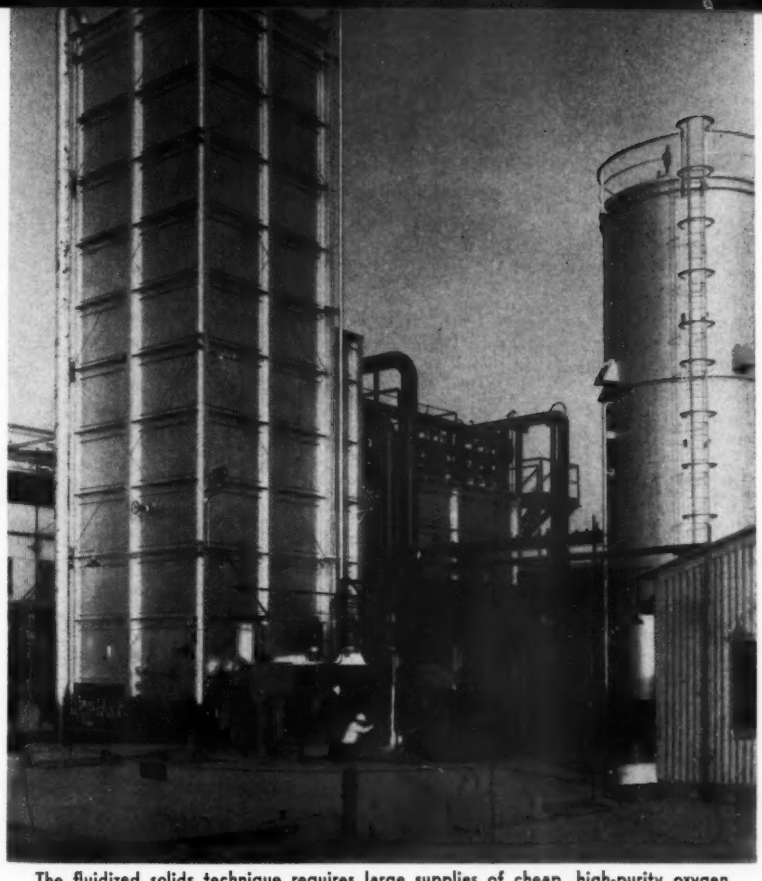
Product Utility

The final operating test of any reduction process lies in the utility of its product. Most steel companies think of direct iron first as a scrap substitute, and secondly as a major source of metallics that under some circumstances might be cheaper than the hot metal from a new blast furnace-coke oven complex. While the freedom of such direct iron from tramp elements such as copper represents a significant advantage, the fact that only the kiln processes, particularly the R-N, contain specific features to separate slag-forming impurities in the reduced product, means that the direct iron will otherwise carry its original silica and alumina impurities from the ore into the steelmaking vessel. Since the blast furnace removes these impurities, melting direct iron containing these impurities introduces operating, and consequently cost, penalties into subsequent electric furnace or open hearth steelmaking.

Further research will lead to some process step with acceptable costs to finish the job of paralleling the blast furnace, by adding a melting step to separate the slag-forming impurities in the direct iron. It would be an important step forward if current trials using the hot blast cupola provide the economic answer desired.

No paper that considers the current deeply rooted research and development of direct reduction should sidestep a forecast, and I do not intend to. No one of the processes being evolved in the United States has been fully demonstrated through the steelmaking step; or if it has, the data have not yet become generally available. By their diversity, it is likely each may find application under conditions that favor it especially; i.e., there will be no one process that has the universal applicability of the blast furnace. However, the quality of the work and the support these costly programs are receiving from large steel company management, both suggest the likely achievement of practical processes. My own view is that we will soon see commercial applications; and moreover, that the resulting economics will look more attractive for new iron and steelmaking facilities than will the cost of a new coke oven, sinter plant, blast furnace, steelmaking complex. This will be an evolutionary process, with little or no prospect of a payout in replacing present facilities. But to the western hemisphere it does open many new doors in making economic use of its reserves of ores and fuels.

The next decade should be a most interesting one to watch.



The fluidized solids technique requires large supplies of cheap, high-purity oxygen —produced in plants like the one pictured

A systematic modernization of the mine haulage system at the Oakmont mine increased production nearly 29 percent to 14.3 tons per man-day. The successful haulage plan involved driving a 665-ft slope for a conveyor installation, laying 2300 ft of new track and installing 30-ft-long bottom dump cars. All this was accomplished with little interference with mine operation

MORE Tons Per Man with LARGE Mine Cars

By JOHN R. PALIN
Chief Engineer
Harmar Coal Co.

THE Oakmont mine of Harmar Coal Co. operates in the Freeport seam, which is normally 7 to 7½ ft thick. The mine is located on the Allegheny River, 14 miles up-river from Pittsburgh, Pa.

The property was originally opened in the 1917-1918 period. At that time three openings were provided—a slope for supplies and manway and two shafts for ventilation and coal hoisting. Handling the coal was typical for the period—small two-ton capacity end-dump mine cars and a double track loaded car storage at the shaft bottom with a kick-back empty car storage track. Cars were hoisted in self-dumping cages and the coal run over Marcus screens for picking and sizing, then to loading booms and railroad cars. Conveying equipment was later added to load on the river.

The mine was acquired by Harmar in 1952. At that time, an adjoining coal tract added sufficient reserve tonnage to justify modernization of the operation. Coal from the mine is loaded raw into barges for shipment to a central plant where it is unloaded, cleaned and reloaded for shipment to the customer; thus, in the modernization, only track, haulage, crushing and conveying into barges had to be considered.

Limited surface area along the river for plant site ruled out a new construction for plant and bottom layout and only modification of existing entries could be considered, keeping in mind continued operation of the mine during the construction. An entry parallel and adjacent to the existing bottom layout was selected as the logical coal dumping point, being on intake air, yet away from all interference with operation. This location lent itself to use of the existing slope for a conveyor installation or also for construction of a new slope and conveyor.

Cost Studies Determine Haulage Plans

Studies were made of costs to remodel the existing manway-supply slope for the conveyor and driving a new conveyor slope. Remodeling was to consist of excavating four ft of bottom from the existing slope, which is 9 ft wide by 510 ft long, plus driving 280 ft of new slope at eight ft width to the dumping point. The entirely new slope was to be 665 ft long and 8 ft wide. In either case the slope was to be concrete lined in bad ground and gunite lined where rock condition permitted.

Considering construction cost, interference during construction and additional conveyor lengths required, a new slope was decided upon. In this instance, bid prices were equal for the new slope and the remodeling owing to uncertainties in remodeling.

Revamping the haulage and purchasing new large mine cars was the major part of the modernization, thus all factors that might affect cost of construction and operating labor and supplies were considered. Decision on type and size of car was made after careful study.

Estimates of quantities of excavation and concrete required for car haul and rotary dump pits for solid body cars were equal to quantities required for the hopper (325 tons in this case) needed for bottom dump cars. Thus, no preference of type of car could be made on this basis.

Total machinery costs were greater for a rotary dump installation than bottom dump cars. New track work required was 5700 ft of track and 19 turnouts for rotary dump, compared to 2300 ft of track and four turnouts for bottom dump.

30-Ft-Long Car Chosen

Physical size of mine car studied was 30 ft overall length, 7 ft wide by 48 in. high, capable of traveling on a 2½ turnout. This size car in solid body type has a capacity of 630 cu ft in drop bottom, a capacity of 412 cu ft. There are mine cars of greater length being used for combined underground surface haulage, however 30 ft length is believed to be a record to date for cars used strictly for underground haulage.

With allowances made for surge capacity in mine cars and a haul averaging 1½ to 2½ miles for the first four to five years of operation, estimates indicated ten percent more bottom dump cars were required than the rotary dump type. Capacity of the solid body unit is 53 percent greater than the bottom dump car. This difference in capacity and number of cars required is due to allowance for the hopper capacity in bottom dumping.

The cost per car of bottom dump units was 20 percent greater than cars for rotary dump, bearing a direct relationship to weight of car. Maintenance of car was considered higher on the drop bottom type, but partially offset by maintenance of rotary dump and car haul. The installation of an automatic rotary dump, however, involved revamping the Oakmont mine bottom and created such cramped track conditions that this was ruled out. For cost estimating purposes, dump operators wages were included. On the basis of the savings in capital charges and variable costs as shown in the two following tables, the drop bottom cars and related construction were selected.

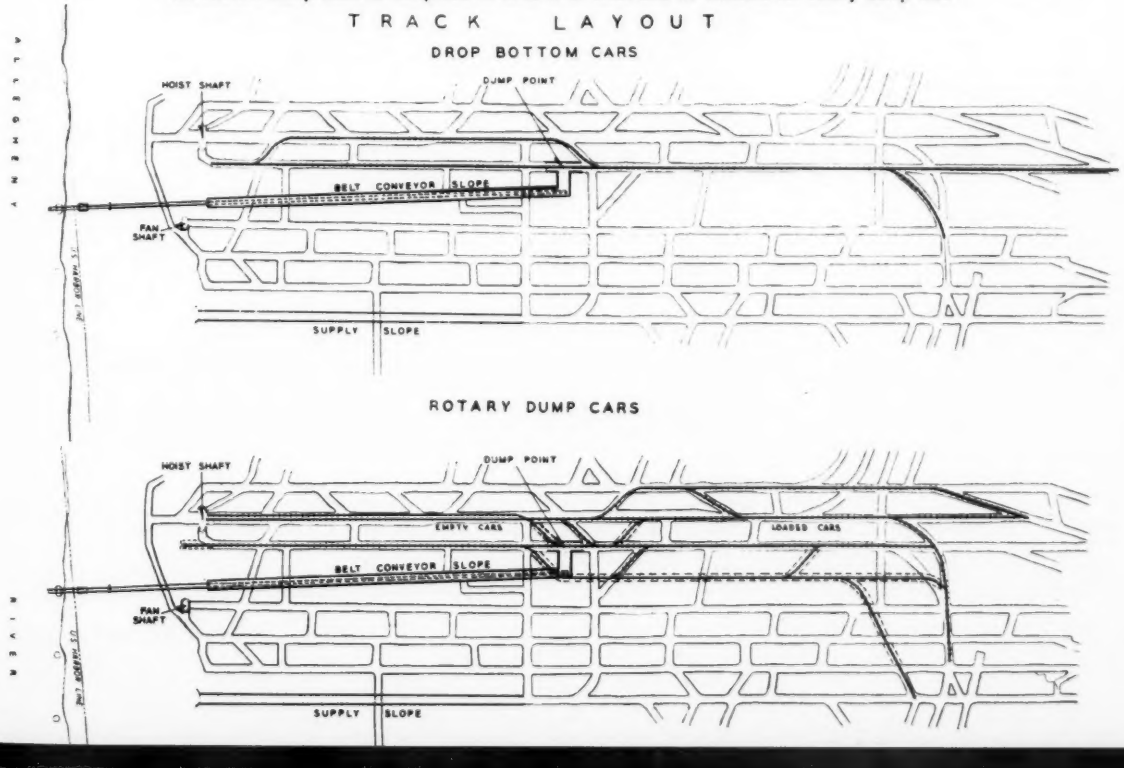
Capital Charges (1955 Estimates)

	Rotary Dump	Bottom Dump
Mine cars	$180,000	$240,000
Slope driving and pit construction	235,000	235,000
Machinery	440,000	380,000
Track and timber	85,000	60,000
Total capital	$940,000	$915,000

Cost Per Ton (Raw Coal) (Based on 1955 Estimates)

	Original Plant	New Plant	
	(Actual)	Rotary Dump (Est.)	Bottom Dump (Est.)
Haulage labor	$0.162	$0.065	$0.065
Dump to barge labor	0.133	0.053	0.037
Car repairs:			
Labor	0.023	0.011	0.017
Supplies	0.018	0.006	0.006
Slope machinery:			
Labor and supplies	0.012	0.010	0.009
Track cleaning	0.017	0.006	0.006
Total variable	$0.365	$0.151	$0.140

Haulage studies revealed that less new track work was required for drop bottom cars—2300 ft of track and four turnouts for the bottom dump units as compared to 5700 ft of track and 19 turnouts for rotary dump cars



General Underground Transportation System

Flow of coal is as follows: Cars are dumped into a 325 ton capacity hopper, all coal being fed into a rock-type 30 by 60 in. single roll crusher, by a vibrating feeder, where the product is reduced to minus three in. Since the coal produced at the mine is entirely for metallurgical use, no effort is made to prevent size degradation. Capacity of the crusher is sufficient to handle the entire product without screening out fines. Discharge from the crusher is onto a 60-in. transfer belt conveyor on 25-ft centers to the 36-in. slope belt. At this transfer point, a 54 by 54 in. suspended magnet is installed for tramp iron removal. This magnet is motorized for both hoisting and trolleying. The motorized trolley is most important to quickly and easily tram the magnet away from the transfer point, drop off tramp iron and return to position.

The slope belt is on 816-ft centers and terminates at a two-bin structure on the river front; a coal bin of 130 ton capacity and a rock bin of 150 ton capacity. Flow of coal is through the bin to a vibrating feeder, to an 80-ft center, 36-in. belt, to a barge loading chute. Mine rock, approximately two percent of the total product, is handled through the same hopper, crusher and conveying system to the rock bin. One of the men on each barge loading crew hauls rock dumped on his shift to the dump which is ½ mile away.

The plant was laid out and designed for simplicity of maintenance and operation; all equipment is operated by the crew of two men at the barge loading chute. Numerous safety devices are used to prevent damage to equipment from spills and pile-ups of coal. All belt conveyor tail pulleys are equipped with centrifugal switches mounted on the pulley shafts. All transfer points have limit switches mounted in such a way that any build-up of coal will shut the system down. Belt conveyors are all straight line, without vertical curves, from tail to head pulleys to eliminate the possibility of spills.

Cleanliness of the plant areas, both surface and underground, was also of prime consideration; all intermediate floors of the plant are steel grating to prevent accumulation of fine coal. The entire plant is piped with wash down water lines with outlets for ¾-in. hose so spaced that a 50 ft length of hose is the maximum required to reach any point in the plant. To wash down the slope, a two-in. pipe line serves as both water line and hand rail.

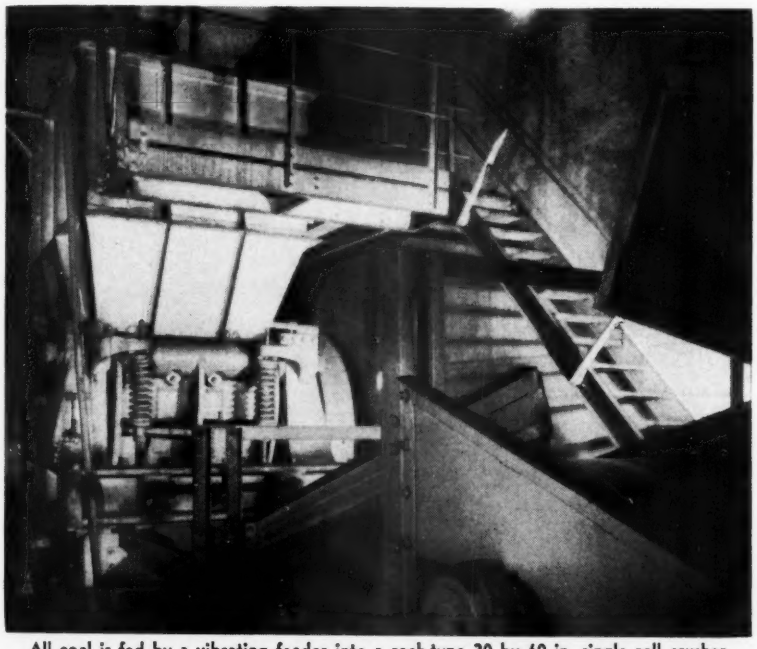
The barge loading crew of two men on each shift are responsible for a section of the surface plant clean-up and have time on their shift each day to hose down their section of the plant. A utility man on the day shift is responsible for minor maintenance and cleanliness of the slope and belt conveyor as well as the bottom installation. These areas are cleaned two to three times each week.

The plant was designed for simplicity of maintenance and operation. All equipment is operated by the crew of two men at the barge loading chute

Returning to the mine cars, several modifications of existing car design were made. The 30 ft length is maximum estimated that could be used on 44 in. track gauge and 2½ turnouts. Hoppering the car bottom to between the trucks permits use of larger diameter wheels without appreciable loss of capacity, thus, 16-in. cast steel wheels are used. Center bearing diameter on the car truck is eight in., compared to six in. or slightly over on most large cars. Provision was made to grease this center bearing down through the center bowl casting.

The cars are equipped with two car haul attachment lugs, spaced one-half car length apart. This decreased the overall length of the hydraulic type car spotter in use at the mine. Without these two lugs, the spotter length would be 39 ft, requiring this length of straight track to properly set up the spotter. With these lugs, required length of straight track is reduced to 24 ft.

Slope driving was started June 1, 1955. Change over to the new plant was made the week of June 10, 1956. In this connection, production was 18,879 raw tons for the week prior to the change over, and 18,475 tons for the same period after the change over. This testifies to non-interference to operation during construction and also to ease of change over.

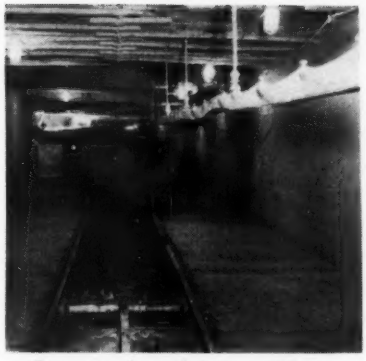


All coal is fed by a vibrating feeder into a rock-type 30 by 60 in. single roll crusher where the product is reduced to minus three in. Since the coal produced at the mine is entirely for metallurgical use, no effort is made to prevent degradation

Track and Locomotives

All mainline track in the bottom layout is 80-lb electric welded rail laid on 5 by 7 in. treated ties on 22-in. centers, ballasted with ⅜ by 1½ in. slag. All other newly laid mainline track is the same. Secondary track is laid with 40-lb rail on No. 5 section steel ties with depressed ends. Looped loading point track is laid on the sections for ease of trip changes at the car loading points. As previously mentioned, hydraulic type car spotters are used at each loading point to shift cars at the ramps.

Haulage from the five producing sections is done with two locomotive crews per shift. Crews consist of two men, each man operating a 13-ton locomotive. These crews change trips at the loading points, haul to the bottom and dump the cars. A locomotive is used on each end of trips. This has advantages on both the sections and at the dump in that locomotives are never required to run around trips.



Cars are dumped into a 325 ton capacity hopper

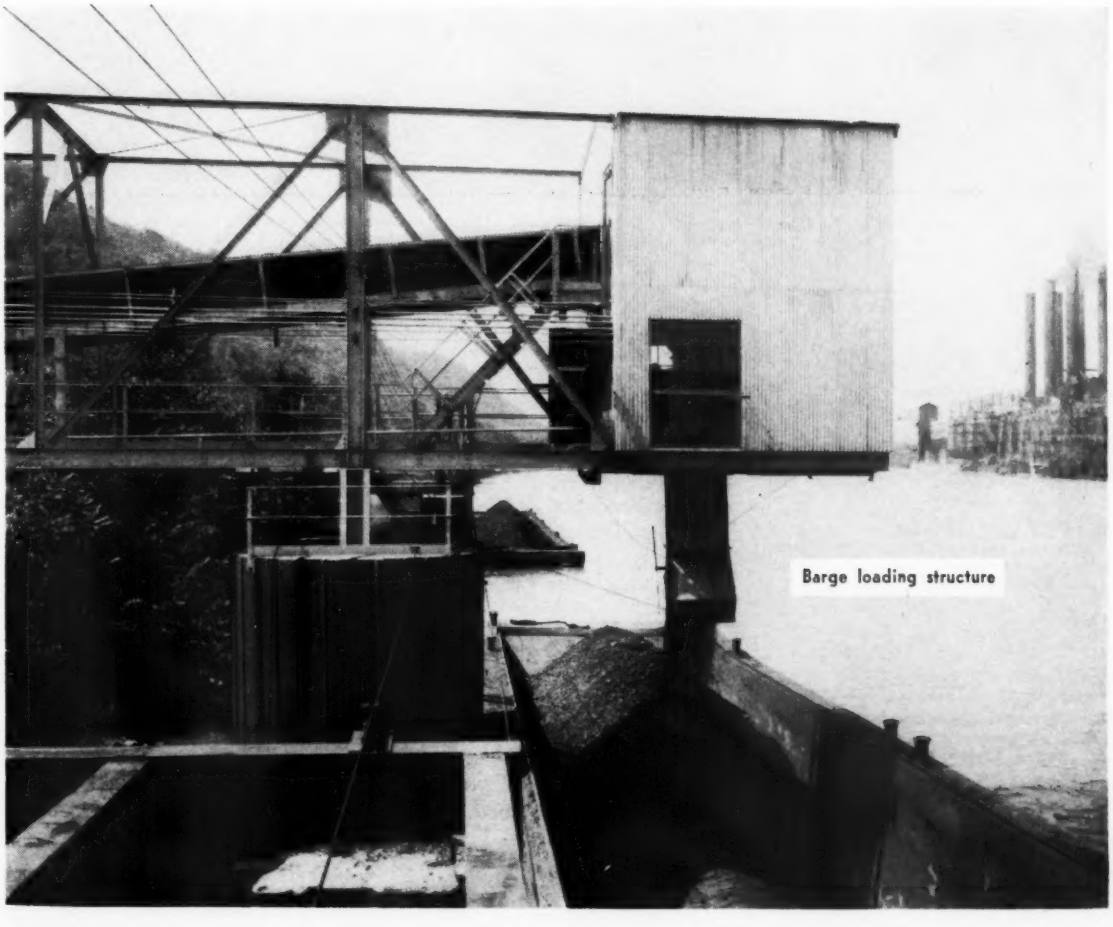
The bottom track layout included a run-a-round track which has never been installed. In the future, as the haul becomes longer and single crews can no longer gather, haul and dump, a larger mainline locomotive will be used and this track will be necessary.

All haulage locomotives, other equipment regularly using the main line and each section loading point are equipped with mine phones for dispatching and communication. With these phones, the haulage crews are kept informed of the car loading in each section and vary their schedule to suit car loading rates.

Proof of improved haulage and coal handling into barges can be seen from the productivity of the mine for the six working months before and after the modernization. The "number of men on payroll" as shown in the following table includes proportionate share of central cleaning plant, tow boat labor to plant, raw coal unloading and general office.

Productivity (Raw Tons)

	Original Plant	New Plant
Average daily production six months before and after change over	3778	3843
Number of men on payroll	263	224
Tons per man day worked	11.1	14.3



Barge loading structure

SINKING AND OPERATION OF CIRCULAR SHAFTS

During one period 730 ft of shaft was completed in 73 working days. The mucker was hoisted and lowered for each round. Here the men position the machine as it is being lowered onto the muck pile

By W. Z. WENNEBORG
Mine Engineer
Intermountain Chemical Co.

Prior to and shortly after World War II, W. Z. Wenneborg worked part and full time as a miner in the coal fields of Illinois. After completion of his education at the Missouri School of Mines, he served as resident engineer for the Union Pacific Coal Co. Since 1953 he has worked for the Intermountain Chemical Co.

IT is not the purpose of this article to present an over-all comparison between circular shafts and those of other cross sections. However, it will be necessary to show some differences to illustrate particular points.

The trona deposit at Westvaco, in southwestern Wyoming, is opened by three circular shafts, about 1500 ft in depth—number one completed in 1947, number two finished in 1953, and number three which was placed in operation early this year. For the first part of this article the engineering, design, and sinking of the number three shaft will be discussed. For operation data in the second part of this discussion, experience with both older shafts will be used.

Number Three Shaft Design

From drill hole data and previous shaft sinking, certain facts affecting design and construction were known. These facts and the shaft purpose, both present and future, governed the final size and shape of the shaft.

1. The prime purpose of the shaft was to increase the volume of ventilating air. The ore is sandwiched in oil shale strata and when full recovery mining is practiced, methane gas is liberated in quantities which could be exceedingly dangerous. Methane removal can be safely handled only by a volume of air sufficient to dilute it to well below the explosive limit. Pillar extraction was practiced only on a limited scale until the completion of this shaft.

2. Shaft sinking would be through horizontal sediments of low strength. All rocks associated with the mine are fairly soft shales which stand unsupported for a limited time. There has been no ground movement in the area. A lining would be necessary, but other factors would determine what type.

3. Artesian water is present and flows from a dense sandstone aquifer about 1200 ft deep. The flow is small —15 to 20 gpm—but is a brine composed of trona, chlorides and lesser amounts of other salts. Past experience has shown shaft maintenance to be easier if this water is eliminated from the shaft or kept to a minimum. If this condition is met, high hydrostatic pressures exist on the outside of a shaft lining.

4. The shaft was to be so located that as mining continued, it could be

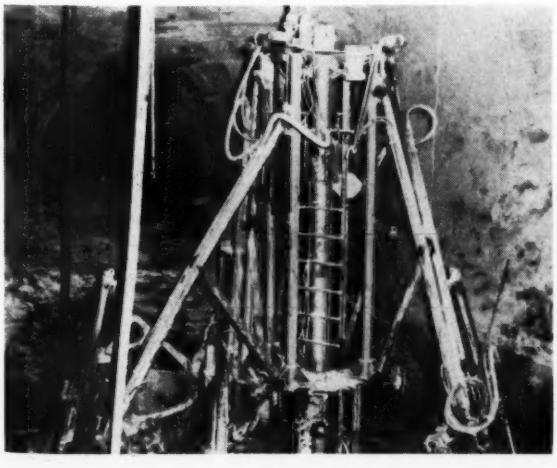
On the far side, under the man, is the opening for the underground duct, constructed to prevent ventilation interference by the cage while it was standing at the surface landing

used in the future for handling men and materials without interrupting ventilating air. Buntons, guides, air locks and hoist were to be in the original design, but were to be installed at some future date.

An evaluation of the ventilation requirements was made. Three hundred thousand cfm of air assured safe mining at anticipated production and also provided a 50 percent safety factor. For this volume of air, the economical size of shaft was 250 sq ft. Assuming a circular shaft was to be used, a diameter of 18 ft satisfied this requirement. To illustrate economical size, the comparison between two shafts, both circular, having diameters of 18 and 10 ft, respectively, can be made. For the larger to pass 300,000 cfm of air, horsepower required is slightly over 55, while the smaller shaft requires almost 20 times the horsepower or over 1000. A square shaft of area equal to the larger circular shaft consumes 62 hp for the same volume of air or 13 percent more. By balancing operating costs against capital cost an economical size may be derived. Ventilation demands favored a circular shaft since pressure drop is least for equal area of any other shaft cross-section. Even with hoisting facilities installed, the passage of air around a rectangular cage would be without excessive shock loads on the system.

A continuous shaft lining would serve three purposes: air friction would be minimized, the shaft walls could not spall and the artesian water would be contained as nearly as possible. Concrete proved the best material to accomplish all three objectives and is also fireproof. Most important, concrete, if resisting hydrostatic pressure, could best do so with a circular cross-section and this design would not need reinforcing rod as the lining is put in compression. Also a saving of 12 percent in concrete could be realized over a square shaft of equal area.

The final design was a circular shaft, 18 ft in diameter and concrete lined the full depth. Provisions for use as a future hoisting shaft were incorporated. Both the shaft station and the surface landing were planned so no ventilation interference by the cage existed while it was standing at either place. This was done by placing an air duct below the surface at the collar of the shaft and by a sloping entrance above the underground station. The latter construction also facilitates the lowering of large pieces of equipment. Number three shaft is now used exclusively for intake ventilation and is presently passing 220,000 cfm of ventilating air.



A round of about 50 holes pulled an average of eight ft of ground. The four-drill shaft jumbo is shown in position on the shaft bottom

Record-Breaking Shaft Sinking

The Dravo Corp. contracted this job and its superintendent, Tom Berry, was responsible for what might be classed as record-breaking shaft sinking. This was possible by using an Eimco crawler and a jumbo drill.

A round of about 50 holes pulled an average of eight ft of ground. The resultant muck was loaded by the Eimco into 2½-yd buckets which were hoisted without guides. This cycle was repeated until 45 ft of shaft was open when concreting behind steel forms was done. Following this procedure, during one period 730 ft of shaft was completed in 73 working days.

Operation Data

All three shafts are circular at Westvaco. Number one is 12 ft in

diameter and handles all men and materials. Number two is 14 ft in diameter and serves as ore production shaft. Both of these shafts exhaust air from the mine. We find a circular shaft an advantage for passage of air around the cage and skips. This additional area also serves for the service facilities, piping, power, etc.

Seepage of brine plus dust in the air form a deposit of recrystallized trona on the shaft lining. Formerly this was scraped off by hand and the lack of corners eliminated the possibility of a tough buildup. More recently, sprinkling rings, flowing fresh water, dissolve the buildup and the resultant liquor is pumped out by regular sump pumps. It is difficult to predict how such a system would work in any other cross-section. Because it has not been possible to seal off all the brine from the shaft, and winter temperatures frequently are sub-zero, the intake air at number three shaft is heated to 40° or more on demand.

Mechanical maintenance with respect to the guides, buntons, linings, etc., has been very low even though the practice is to retain a full time shaft repairman. This repairman also assists the cager in handling some materials in addition to maintaining all three shafts.

Each operation will have certain conditions which will dictate the shaft design. None will be identical to any other. Westvaco has been well pleased with circular shafts and, unless conditions change, future shafts will undoubtedly be the same type.

No. 3 shaft, 18 ft in diameter and concrete lined the full depth, is presently passing 220,000 cfm of ventilating air. In the left foreground is the heater house for maintaining air temperature at plus 40° F

THE GRANTS AND AMBROSIA LAKE AREAS

(Continued from page 44)

operation in January 1956 and processes 2,500 tons of ore per day. It employs a resin-in-pulp circuit, using ion exchange to recover the concentrates. About 300 men are employed in both plants.

North of the Jackpile mine, the Saint Anthony Uranium Corp., a subsidiary of Climax Molybdenum Corp., recently completed sinking a shaft on the Seboyeta Grant and the first shipment of ore was made during the past month.

22 Companies Interested in Ambrosia Lake District

The Ambrosia Lake district, where uranium was discovered in April 1955, lies about six miles north of the Haystack and Poison Canyon properties. The district embraces about 75 square miles and more than 25 deposits of varying size have been proven. Many of them contain ore reserves in excess of five million tons.

There are 22 companies interested in the Ambrosia Lake district. Among the major companies are the Kerr-McGee Oil Industries, Inc., Homestake Mining Co., Vanadium Corporation of America, Phillips Petroleum, Holly Uranium, Rio de Oro, affiliated with Atlas Corp., and Climax Uranium Corp., a subsidiary of Climax Molybdenum.

Something over a year ago, Rio de Oro sunk a shaft and bottomed it at 350 ft. This company was the first to commence ore shipments and has been doing so for about a year. An additional shaft has been collared and sinking is under way. Holly Uranium is also producing ore from its shaft in Section 14, T14N, R10W.

Kerr-McGee has completed one shaft. They are sinking another, and one additional shaft has been collared in preparation for sinking. Homestake Mining has completed one shaft and two others are collared. In addition, Phillips Petroleum Co. and Vanadium Corporation of America are presently sinking shafts.

As of this date, there are 12 shafts in the district. All of them are either three or four compartment types. Dimensions vary between 6 by 13 ft for three compartments to 11 by 14 ft for the four-compartment shafts.

Some water has been encountered in the shaft sinking operations, when the water table is encountered at about 400 ft depth in the shafts.

The ore horizon in the district, with one exception, is between 600 and 800 ft below the surface, and as in other parts of the Grants and Laguna Districts, it occurs in the Westwater sandstone of the Morrison formation. In some instances, four different ore horizons have been discovered during drilling operations. The ore varies in thickness from 6 ft to as much as 50 ft.

Four More Mills to Be Erected

The Kerr-McGee Oil Industries are planning the erection of a mill on Section 31, T14N, R9W, near Ambrosia Lake. The plant will have a milling capacity of 3500 tons per day.

The Homestake-New Mexico Partners are presently building a mill near the San Mateo Road approximately 15 miles north of U. S. Highway 66. This mill will process 750 tons per day and the completion date is January 1, 1958.

Immediately adjacent to the last mentioned mill, Homestake-Sapin Partners have acquired a mill site immediately north of the Homestake-New Mexico Partners mill. The erection of a 1500-ton mill on this site was recently commenced and the plan is to have it in production about the middle of 1958.

Phillips Petroleum Corp. is also negotiating with the AEC for the construction of a mill in the Ambrosia Lake area. This mill will have a daily capacity of 1500 tons.

In addition, to the Anaconda mills now processing 3000 tons of ore, there will be four more mills in the Grants-Ambrosia Lake Districts. The combined tonnage to be processed in these districts will amount to 10,250 tons per day, or about 3¾ million tons per year.

It is reported that 125 million dollars has, or will be spent in the Grants-Laguna and Ambrosia Lake Districts. This statement illustrates how important these areas are to the economic welfare of the nation and to the state of New Mexico.

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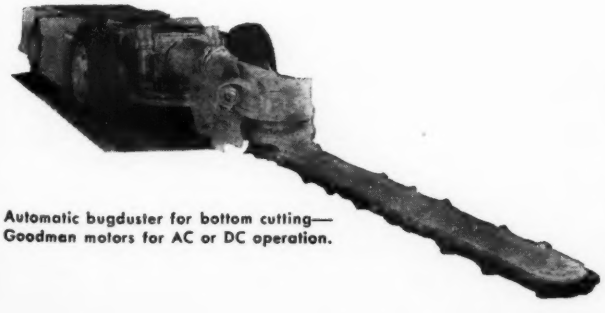

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THE TRACTOR-SHOVEL IN TODAY'S MINE

By W. A. HALEY
Caterpillar Tractor Co.

A BONUS machine for the mine operator in today's search for efficiency is the tractor-shovel, or front-end loader, offering ability to perform a variety of useful jobs in mining operations. This adaptable machine is being assigned more and more demanding tasks around both open pit and underground mines as management becomes acquainted with the many benefits offered by the general purpose rigs.

The hydraulically-operated tractor-shovel of today, unlike models of yesteryear, is a specially-designed unit, rugged, mobile and productive. Not only can it do shovel work, it also has the built-in ability to operate as a crawler tractor. As a shovel, the loader is not limited to a confined area of application. Manufacturers are constantly extending its range through the design of attachments which adapt the machine to entirely new situations. Available are tools which outfit the tractor-shovel for almost any mining job that can be performed by a loader or a conventional crawler.

The prime tool for any tractor-shovel is the bucket, and a variety is available, from the highly specialized light materials bucket to the rugged quarry unit. Light materials buckets are for use in loose, light weight materials and have a larger capacity than the heavy-duty units.

Quarry buckets, rigid and able to withstand heavy, continuing shock, are designed to fit special needs in quarrying and mining. Tough teeth, welded to the cutting edge, protect the edge and help ease loading in jumbled rock. The advent of strong tools of this type, coupled with development of lever prying action from the bucket tilt-back, enables the tractor-shovel to break stubborn material and to perform jobs never attempted before.

Also available for the tractor-shovel are several specialized attachments such as the skeleton rock bucket which grades material size as it digs it from the ground.

A recent innovation in bucket design is the side dumping model. Hinged at the side of the bucket frame, the side dumper can pick up a load and, without turning, cast it sideways into the bed of a haul unit. Because it casts to the side as well as forward, parallel loading is made possible. That is, the truck parks beside the loader which has only to back away from the stockpile and dump to accomplish its job. No turning is necessary; as a result, the side-dumping bucket reduces loading time per unit, and maintenance cost. This type of unit is ideal for work where maneuvering area is limited.

Because of the wide range of tools available, the tractor-shovel offers almost unlimited versatility to mines, large or small. It can work as an auxiliary production tool by loading haulers, or, at smaller mines as the primary loading unit for the entire mine operation. At one site, a tractor-shovel loads material into the crusher hopper, loads the stockpiled material into trucks, and is also used for miscellaneous work around the area.

A tractor-shovel is well suited to operation around the large loading shovels, by cleaning ahead of the big unit and then stacking or loading trucks with material spilled or missed during regular loading. An Indiana pit uses a tractor-shovel to clear for the loading unit and to push loose material to within reach of the big shovel. A big plus is its ability to move from job to job rapidly. Highly maneuverable in comparison to the large shovels, the tractor-shovel can rapidly shift to another work area at up to seven mph.

Around the mine there are scores of jobs that can be handled by a tractor-shovel in off-time. Because of its ability to pick up items and reach into the air, the unit can act as a mobile hoist. At a Missouri mine a loader is used to raise large, heavy parts, placing them where they are needed. Over six tons can be lifted by these machines. In this capacity the loader performs another bonus operation.

In addition to these different uses as shovel and hoist, the loader can do much of the work performed by a conventional crawler at the mine site. Manufacturers have designed special bulldozer blades which fit the arms of the loader. Either straight or angling blades are available and the machine can be converted to bulldozing or back to loading in a few minutes' time. With the blade, the loader can do routine bulldozing activities, such as light spoil removal, road building, land clearing and even haulroad grading.

Rear-mounted rippers help to break up material for later removal by the tractor-shovel's bulldozer or bucket. Cover can be loosened in a few passes, then loaded into haulers by the bucket. By mounting the teeth backwards in the carrying bar, material can be ripped while the machine is backing up to get a new load in the bucket, thus saving time.

By hooking a scraper to the drawbar, the tractor-shovel is converted to a prime mover and can double as a production unit by loading the scraper and hauling ore to the grizzly.

Underground, the tractor-shovel can perform many of the jobs that it can do above ground and, in addition, handle operations peculiar to underground mines. With two to four drills mounted on the bucket frame, the loader can drill high spots easily because of its high-reaching arms. By replacing the bucket with a platform, a special mount for roof bolting crews can be provided.

Manufacturers have overcome the initial problem of the diesel exhaust gasses in underground mines. With a scrubber and adequate ventilation, a diesel tractor-shovel can operate below ground 24 hours a day without causing ill-effects to personnel. In gaseous atmospheres, owners have utilized the loader's versatility by removing the engine and installing electric motors.

As an earthmover, production loader, road builder, prime mover, bulldozer and grader, the highly mobile tractor-shovel offers versatility and flexibility to the mine owner. With a large variety of tools available, the tractor-shovel is indeed the bonus machine for mine owners today.

Wheels of GOVERNMENT

AMC

As Viewed by HARRY L. MOFFETT of the American Mining Congress

The launching of Sputniks I and II plus the revelation of the slow progress being made by the United States in the fields of space satellites and rocketry have turned the attention of Federal lawmakers and Administration officials away from purely domestic economic problems to the more pressing problems of national security.

The scientific advances of the Soviet have also brought to a halt drives to obtain tax relief for individuals. The President, other Administration officials, and a number of Capitol Hill spokesmen have publicly declared that defense outlays will rise to a point that will preclude any possibility of tax reduction in the year ahead.

The coming session of Congress will see numerous investigations into our military program, into the conduct of our foreign aid plans, and the extension of the Trade Agreements Act, as well as into such domestic matters as the farm program and fiscal policy, etc.

The Administration is shaping its new budget about defense, and Departments and agencies not connected with defense have been directed to prune their financial requests sharply to offset the anticipated rise in security outlays. Finishing touches are also being put on the Administration's legislative program which will be submitted to Congress by the President in January.

Labor Law Changes Proposed

Following in the wake of the shocking revelations in the labor field by the McClellan "Rackets" Committee, an increasing number of proposals have been advanced for amendment of U. S. labor laws. The source of many of these proposals would indicate that some steam may be put behind a drive to obtain a few major amendments at the next session of Congress.

Labor Secretary James Mitchell has told newsmen that the Administration will probably urge Congress to approve amendments which would (1) provide criminal penalties to curb so-called "union-busting" operations, (2) ban "blackmail" picketing, in which a union seeks to impose a union contract where neither the employer nor the employes desire it, (3) require unions to hold secret ballot elections for officers at least every four years, and (4) require complete exposure of union dues and welfare fund expenditures.

Mitchell, however, threw a damper on proposals for a national right-to-work law, saying that the Administration will not advocate such a move. He also said that he is personally opposed to application of the anti-trust laws to unions but that the Administration has not as yet taken a position on this matter.

Senator Irving Ives (Rep., N. Y.), vice-chairman of the Senate Rackets Committee, has also outlined changes which he plans to seek in the labor laws. He said he will formally introduce proposals at the next session to (1) insure democracy in labor organizations by requiring secret ballots in union elections and votes on matters governed by membership action, (2) prevent misappropriation and misuse of union funds by empowering the Secretary of Labor to investigate financial reports of unions and to pass along any suspected false reports to the Attorney General for appropriate legal action, (3) ban picketing by a union for purposes of organization or recognition where representation petitions filled by another union or by the employer are pending before the NLRB, and (4) extend the bribery and extortion provisions of the Taft-Hartley Act to management consultants, and make the violation of such provisions a felony rather than a misdemeanor as now provided.

Ives also pointed out that he would seek approval of two other measures, which he introduced last session, which call for registration, reporting and disclosure of employe welfare and pension benefit plans, and for elimination of the "no man's land" jurisdiction between the NLRB and State labor agencies.

Chairman McClellan (Dem., Ark.) of the same committee has stated that he expects Congress to act on legislation to curb misuse of power by unions and union leaders at the next session.

Another Freight Rate Boost?

Representatives of the Nation's railroads held several meetings during November, at which they drafted a request for new freight rate hikes to be submitted to the Interstate Commerce Commission. Basis of the proposed new rate increases differs from those previously requested, in that the carriers are heeding an ICC admonition of last summer that any further rate petitions should spell out the precise increases sought on specific commodities rather than ask for across-the-board percentage-wise hikes.

During the Novemebr meetings, differences over the details of the proposed request to the ICC cropped up and delayed submission of the formal application. According to reports, some rail groups were opposed to requests on several of the specific commodities favored by other groups.

Railroad leaders apparently have not taken kindly to the new method of applying for rate increases. They have commented to the press that the current petition is in the nature of an experiment. They said that if the ICC holds extensive hearings on each commodity rate proposal they "cannot afford to stand around waiting on another petition of this sort."

It is understood that the rails will seek increases on some mineral commodities and on services affecting the transportation of minerals. As of this time the petition is not yet before the Commission, and there has been no indication as to how long the hearings

Washington Highlights

TAFT-HARTLEY ACT: Revisions proposed

FREIGHT RATES: Rails prepare request to ICC

STOCKPILE: Goals being reviewed

OIL IMPORTS: Residual survey to be made

ALASKA LANDS: Open to mineral entry in 1958

LEAD-ZINC: Tariff Commission hearings held

and Commission study will take before a decision is reached.

Stockpile Review Undertaken

A special Stockpile Advisory Committee, composed of 12 members and headed by Holman D. Pettibone, chairman of the board, Chicago Title and Trust Co., has been named by ODM Director Gordon Gray to thoroughly study U. S. stockpile needs. The study was initiated as a result of a shift in defense planning from an estimated five-year to a three-year involvement in any future all-out war.

In view of the fact that ODM has announced that present goals for a great number of minerals have been met and that others are fairly well along, it would appear that the findings of the Advisory Committee would be such as to slow future stockpiling conisderably, and even to show the existence of excesses in several cases. Present law, of course, provides for checks on the disposition of stockpiled materials to prevent any disruption of the domestic economy.

Elsewhere in the stockpiling field, the Agriculture Department's program of bartering farm surpluses for strategic commodities abroad has declined sharply as a result of the restrictive regulations adopted this summer. The report for the third quarter of the year showed barter contracts totaling only $400,000 as compared with $64,000,000 worth of contracts in the same quarter last year. Agricultural Department officials have not indicated that there will be an increase in the present tempo of barter negotiations.

New Oil Import Survey

Importers of residual oil will shortly have to supply the Government with monthly reports as to the quantity of residual oil being brought into the United States and as to planned imports.

ODM Director Gray made this plain in a letter to Senator Margaret Chase Smith (Rep., Me.). He also defended the voluntary crude oil import curbs imposed by ODM, stating that they are necessary to maintain a going domestic petroleum industry. The heavy influx of residual oil has been harmful to the domestic coal industry, railroads and mine labor, and has brought forth repeated demands from members of Congress for legislation setting quotas on such imports. A further drive in this direction is anticipated at the next session of Congress.

Meanwhile, the Interior Department has issued a report showing that crude oil imports in October fell below the Government-recommended level for the first time since the voluntary import curb was imposed in July. This situation may be short-lived, however, since the Department has also announced that oil companies expect to import an average of 794,000 barrels of crude daily for the five months from November through March, which would exceed the 771,400-barrel daily quota set by the Government under the import program.

Alaska Lands Opened to Mining

Interior Secretary Fred Seaton has announced that 20 million acres of northern Alaska public lands will be opened to mineral leasing and mineral entry about September 1, 1958. The land lie in an area approximately 150 miles north of the Arctic Circle and are both east and west of Naval Petroleum Reserve No. 4. The proposed opening of the lands is subject to receipt of comments from interested parties and study of them by Interior Department officials. The comments are due late this month.

The proposed opening of the lands was hailed by Alaska's Governor Stepovich, who termed it a tremendous step forward in developing the natural resources of the Territory.

Lead-Zinc Tariff Hearing

The U. S. Tariff Commission completed six days of public hearings November 26 on a petition of the Emergency Lead-Zinc Committee for a maximum increase in tariff rates on lead and zinc metals, ore, and concentrates, and the imposition of import quotas on these commodities, under the "escape-clause" provision of the Trade Agreements Act.

Lead-off witness was Charles E. Schwab, chairman of the Emergency Committee, who said that "the injury now being sustained by the domestic industry can be brought about only by curtailment of excessive imports." Under existing law, he pointed out, the duty on pig lead can be advanced from 1 1/16 cents a pound to 2.55 cents, and on slab zinc from 0.7 to 2.1 cents a pound—increases of 1.48 cents and 1.4 cents respectively. These increases, standing alone, "are not enough to correct the injury being sustained by the domestic industry," Schwab continued, but in conjunction with import quotas "would be an adequate remedy."

Other members of the Emergency Committee presented data and statistics on mine shutdowns and unemployment in the lead-zinc industry and on specific details of the proposed import quota plan.

Many Western Senators and Representatives endorsed the Committee's petition and urged the Tariff Commission to recommend maximum relief to the ailing industry.

Witnesses opposed to relief measures included representatives of mining companies and Government spokesmen from Canada, Mexico, Peru, and Bolivia.

The Tariff Commission must now decide (1) whether the lead-zinc mining industry is threatened with or has actually suffered injury and (2) whether this injury is the result of tariff concessions granted under the Trade Agreements Act. The Commission will then make its recommendations to the President, who will make the ultimate decision as to what relief will be granted.

"Why all this bother—can't the AEC just tell you where it is?"

AMC Personals

Retirement of **Oliver C. Ralston**, chief metallurgist of the Bureau of Mines since 1949, has been announced by the U. S. Department of the Interior.

Ralston joined the Bureau as a junior chemist at Pittsburgh, Pa., in 1912. After working for two years in coal chemistry, he was assigned to metallurgical research, a field in which he was engaged with the Bureau until his retirement, except for two periods in private industry.

He was largely responsible for development of the Bureau's metallurgical program from a single station at Salt Lake City, Utah, which he helped establish in 1914, to its present position of international prestige, the Department said.

In recognition of his contributions, the Department in 1953 presented him its highest honor, the Distinguished Service Award and Gold Medal.

Robert L. Frantz, formerly with the Pocahontas Fuel Co., Pocahontas, Va., has been appointed assistant professor of mining engineering at Ohio State University. Before joining Pocahontas Fuel, Frantz was associated with J. W. Woomer and Associates, consulting mining engineers, and the Warner Collieries Co. in Ohio and West Virginia.

Harry B. Gloss was appointed purchasing agent of Boone County Coal Corp. November 1. Gloss joined Boone County in September following 17 years employment in the purchasing, accounting and engineering departments of the U. S. Steel Corp. at Gary, West Va.

Dr. Frederick C. Kruger has been appointed director of mining and exploration for International Minerals and Chemical Corp. He joined the company last February as chief geologist and since June has been acting department head.

Before joining International Minerals, Kruger was assistant chief geologist for Reynolds Metal Co., and before that held the same position with Cerro Dude Pasco Corp.

J. K. Peters, assistant treasurer, and long-time employe of Pocahontas Fuel Co., retired October 31. He was succeeded by **Richard L. Chambers**, who had been assistant secretary and supervisor of the IBM department. **Randel O. Bond** has been appointed assistant secretary to succeed Chambers, and **Richard L. Morrissette** succeeded Chambers as supervisor of the IBM department.

Raymond G. Lindlof, formerly geological engineer with the Atomic Energy Commission in Casper, Wyo., has been appointed chief engineer and geologist for Federal Uranium Corp., according to Ralph W. Neyman, president.

Lindlof worked for several years for the Hecla Mining Co., Wallace, Idaho, as geological engineer and shift boss. He has been employed by the Atomic Energy Commission in the Casper office for the past four years.

Hugh B. Lee, Jr. has been elected executive vice-president of Maumee Collieries Co., Terre Haute, Ind.

W. Aubrey Smith, general manager of Southwest Potash Corp's. Carlsbad, New Mexico operation has been elected a vice-president of the company. **V. A. Zandon**, former assistant general manager, was promoted to general manager, and **John Sowers** was promoted from mine superintendent to general superintendent.

Russell G. Haworth, vice-president in charge of production, and resident manager for the Potash Company of America at Carlsbad, N. M., has been elected to the board of directors of PCA.

Duval Sulphur and Potash Co. has announced the appointment of **Randal H. Taylor** as mine superintendent at the Carlsbad operation of the company. For the past three years Taylor has served as assistant chief engineer for Climax Molybdenum Co. at Climax, Colo.

L. Stevens Condor, formerly assistant mine engineer at the Carlsbad, N. M., operation of the Potash Company of America, was named staff engineer recently.

J. Ranald Fox, works manager of the alumina plant at Aluminum Company of America's Point Comfort operations since early 1956, has been named assistant general manager of Alcoa's refining division. **A. B. Kaltwasser**, alumina plant production manager at Point Comfort, succeeds Fox as works manager.

The following promotions have been announced by Chile Exploration Co., subsidiary of the Anaconda Co.

Joseph C. Allen, assistant general superintendent of plants since March, 1957, was named general superintendent of plants. **David Sanders**, concentrator superintendent of the sulphide plant, has been named assistant general superintendent of plants, and **Charles M. Lagergren** succeeds him as concentrator superintendent. **Francis E. Jones** was named assistant to the concentrator superintendent, and **Peter B. Hobsbawn** was named concentrator general foreman.

Francis J. Burke has been appointed assistant general traffic manager of the Anaconda Co. Burke has served the organization since December 1940 and has held the position of district traffic manager in New York since May 1948. He succeeds the late William J. Findlay.

John R. Coulam, formerly district traffic manager for International Smelting & Refining Co. at Salt Lake City, Utah, has been appointed district traffic manager in New York to succeed Burke.

C. F. Fogarty

E. C. Meagher

E. F. VanderStucken, Jr.

Texas Gulf Sulphur Co. has announced the election of three new vice-presidents. They are **C. F. Fogarty**, manager of the company's geological department in Houston; **E. C. Meagher**, treasurer of Texas Gulf Sulphur; and **E. F. VanderStucken, Jr.**, secretary of the company.

William M. Weaver, Jr., president of Haile Mines, Inc., of New York, N. Y., and its wholly owned subsidiary, Frank Samuel & Co., Inc., of Philadelphia, has announced that **Thomas T. Fleming, Jr.**, has been elected a director and vice president and general manager of Frank Samuel & Co., Inc.

Fleming has been associated with Frank Samuel & Co., Inc., since 1950 and for the last few years has been vice-president and sales manager of that company and its affiliate, Refractories Corporation of America.

A new appointment to the staff of Bituminous Coal Research, Inc., and the promotion of a BCR staff member have been announced by Dr. H. J. Rose, BCR vice-president and director of research.

Maurice Deul, former research geologist with the United States Geological Survey, has been assigned to BCR's Pittsburgh laboratory, where he will devote his efforts to the field of earth sciences, primarily to chemical and mineralogical research and

Mr. Deul

R. L. Sankey

to economic geology. His initial assignment is a study of the forms of sulphur in coal to discover new methods which will permit a removal or decrease in the amount of sulphur in metallurgical and steam coals.

Robert L. Sankey of BCR's Pittsburgh staff has been promoted to publications manager. In his new job, Sankey, who is widely experienced in the production of publications and other visual materials, will assist in planning the BCR publications program and will provide direct supervision over its execution.

Charles J. Brown has been appointed sales manager of Cuban Nickel Co., subsidiary of Freeport Sulphur Co. Brown joined Freeport in 1955 and for the past year he has had an active part in the company's new nickel-cobalt project.

North American Coal Corp. has announced the election of **L. James Wade, Jr.**, as treasurer.

Joseph C. Abeles has been elected a director of Haile Mines, Inc. He is a director, vice-president and treasurer of Kawecki Chemical Co., and a director of Hexagon Laboratories and Talco Engineering Co.

— *Obituaries* —

Ross Bryan, 71, vice-president and general manager of Tricounty Fuel Co., a strip mining firm in Pennsylvania, died September 17.

Dr. Paul Dyer Merica, 68, retired president of The International Nickel Co. of Canada, Ltd., died October 20 following a heart attack.

Dr. Merica, who retired as president of the large nickel producer in 1954, was a director of The International Nickel Company of Canada, Ltd., and its U. S. subsidiary the International Nickel Co., and of American Metal Co., Ltd. He first became associated with International Nickel in 1919, subsequently becoming director of research. He became assistant to the president of the company in 1932, a director in 1934, vice-president in 1936, executive vice-president in February, 1949, and president in 1952.

James H. Leffard, 63, an executive of the United States Steel Corp., died August 17. He was assistant superintendent of the corporation's Coal & Chemical Division and had been associated with the company since 1919.

Walter S. Patton, Jr., 59, purchasing and land agent for the DeBardeleben Coal Co. died October 11 of a heart attack.

Walter G. Hay, 55, superintendent of the Anaconda Wire & Cable Co., Great Falls, Mont., died in September, after being a hospital patient for six days.

Mr. Hay joined the Anaconda Co. in 1923. After serving in Anaconda's zinc plant in various positions for several years, he was transferred to the wire mill in 1930. In 1937 he was appointed assistant superintendent of the rolling mills department and in 1949 became rod and wire mill superintendent.

Early in 1954 Mr. Hay spent two weeks at Vasteras, Sweden, studying aluminum mill operations at the A. B. Svenska Metallverken in preparation for establishment of Anaconda's aluminum rolling mill.

Leroy Salsich, 78, retired president of Oliver Iron Mining Division of United States Steel Corp. died in Duluth, Minn., on October 27.

Mr. Salsich joined Oliver in 1901 and became chief district engineer at Hibbing and Coleraine, Minn., from 1902 to 1906. He was made president in 1930 and served in that capacity until his retirement in 1946.

During World War II, the American Institute of Mining and Metallurgical Engineers awarded him the William Lawrence Saunders gold medal for professional achievement and for "significant contributions" to national steel production.

J. V. McKenna, 57, a well known Pennsylvania State mine inspector died October 17 of injuries suffered in a fall at his home.

George O. Argall, 78, pioneer Colorado mining engineer, mine operator and business executive, died of a heart attack in Denver on October 17.

Mr. Argall was active in mining throughout the west. From 1932 until his death, he maintained a consulting engineering office in Denver, making many examinations and reports covering mining properties in the western part of the United States, Canada and Mexico. His last major activity was consulting engineer and treasurer for the Penn Mining Co. which owned the Penn copper-zinc mine at Camp Seco, Calif., and which was operated by the Eagle Shawmut Mining Co. during World War II.

Rex Robert Seeber, widely known Michigan copper mining man and Professor of Mechanical Engineering at Michigan College of Mining & Technology, died October 19. He was 78.

For the first 20 years of his business career, Mr. Seeber was active in the mining industry of the midwest. Initially he identified himself with the Copper Range Railroad as a surveyor. In 1905 he was employed by the American Mining Co. as an engineer on the Marquette iron range. In 1906 he joined the Winona Copper Co., at Painesdale, Mich., where he served as superintendent until 1918, later going with the St. Mary's Mineral Land Co. In 1922 he joined Michigan Tech as professor of mechanical engineering and became the head of that department several years later.

Eastern and Central States

Crucible Acquires New Coal Reserves

Crucible Steel Co. of America has acquired the rights to more than 15,000 surface acres of additional coal reserves.

The acreage, located at Hugheston, W. Va., on the Kanawha River, southeast of Charleston, W. Va., is expected to yield in excess of 20,000,000 tons of Number Two Gas Seam high volatile metallurgical coal. At Crucible's present rate of consumption, the newly acquired tonnage along with present coal holdings makes available at least a 40-year supply for the company, more than doubling its previous coal reserves.

The new reserves will enable Crucible to extend the span of operations at its present mine at Crucible, (Greene County), Pa., from an estimated 18 more years to about 35 more years.

In making the announcement for Crucible, Joel Hunter, president, said, "The coal acquired in the Hugheston area is a superior quality high volatile metallurgical coal with low ash and sulphur content. When mixed with our Pittsburgh seam coal, it will yield a materially improved coke for use in the blast furnaces at our Midland (Pa.) Works."

Crucible's new West Virginia acreage is a combination of properties in the mountainous terrain around Hugheston. Included are 8000 acres leased from the David Ward heirs, with Valley Camp Coal Co. selling its previous leasehold; 4500 adjacent acres of virgin coal owned by Lewis Holding Co. and sub-leased from Warner Collieries; and 2800 more adjacent acres leased from Kanawha & Hocking Coal Co. The entire area will be developed by Crucible as a unit mine.

Crucible has also purchased outright from Valley Camp and the Ward heirs 80 acres of surface in and around Hugheston and all equipment and facilities used in Valley Camp's mining operations there.

Valley Camp recently suspended operations at its Hugheston No. 3 mine, idling about 150 employes. This basic work force will be offered employment by Crucible, with an increase in force as soon as a step-up in operations can be effected. Additional equipment for coal washing and other above-ground operations will be installed as increased production develops.

In addition to the acreage purchased on the right bank of the Kanawha, at Hugheston, Crucible has bought land stretching along the opposite bank for about 1000 feet at Pratt, W. Va. This frontage will be used primarily as a terminal point for river barges.

Louisiana Cement Plant Opens

The Lone Star Cement Corp. officially opened their new multi-million dollar plant for the manufacture of portland cement at Lake Charles, La., recently. It is expected the new plant will produce 28,000 sacks of cement per day.

The new raw materials storage building covers an area the size of a football field. Twenty-four precast concrete girders, each 104½ ft long, span the building 16 ft apart. They support precast concrete roof panels more than 65 ft above the floor.

To support the weight of the new buildings on the soft, alluvial soil, more than 197,000 lineal ft of concrete piling, some driven to depths of 100 ft, were required. These also support kilns, a 225-ft stack, a mill and storage building. There also are 20 cement storage silos, a packhouse and eight slurry blending and storage basins, each 38 ft in diameter and 32 ft deep.

It is expected the plant will operate around-the-clock and employ 150 persons.

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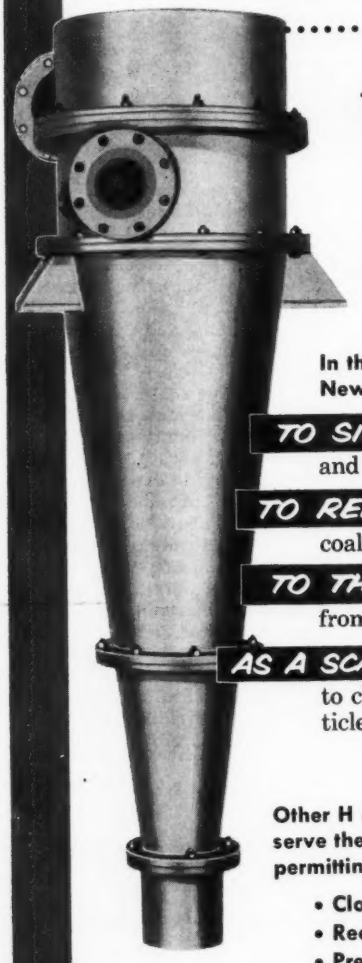

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Peabody Shifts Operations

The Peabody Coal Co. is in the process of integrating all its operations under one roof in St. Louis, Mo. The move started in November and includes moving operations from Kansas City and Chicago, according to Merl C. Kelce, president of the company. It is expected that the entire move will be completed by mid-February.

Peabody began by moving its executive offices and part of its accounting staff from Kansas City in November. The remainder of the accounting office will be moved from Kansas City and the company's sales headquarters will be transferred to St. Louis from Chicago by mid-February. Peabody's mine operating and engineering staff have been located in St. Louis for many years.

The new building will be three stories containing 42,000 square feet of floor space plus a basement parking garage for 40 cars. It will be constructed of black granite and aluminum and be completely air conditioned.

"The majority of our operations are closer to St. Louis than to Kansas City or Chicago and the move will give better service to our customers," Mr. Kelce said.

Shaft Sinking Record

All monthly records for gold mine shaft construction have been reportedly broken at No. 2 shaft, Free State Saaiplass Gold Mining Co. Ltd., South Africa. A total of 834 ft of shaft was sunk in September, surpassing the previous record of 763 ft held by West Consolidated Mines at their Monarch Shaft.

TVA Uses a Lot of Coal

Steam-electric plants of the Tennessee Valley Authority are burning coal at a rate of 35 tons per minute compared with only a ton a minute rate seven years ago, according to figures released recently by the Authority.

TVA officials said that seven years ago 90 percent of TVA's power output came from its vast network of multi-purpose dams. Now it gets 75 percent of its power from steam, and about half of this goes to atomic plants.

During the year ending last June 30, TVA steam plants consumed 18,239,678 tons of coal as compared with fiscal 1950 in which only about 500,000 tons were used. The largest coal generator, the Shawnee Steam Plant which serves Paducah, Ky., atomic plants, burned 4,792,685 tons last year. The Kingston Steam Plant serving Oak Ridge was second, having consumed 4,698,508 tons.

Big Fluorine Contract Set

International Minerals & Chemical Corp. will supply Kaiser Aluminum & Chemical Corp. with more than 10,000 tons of a fluorine compound annually under a multi-million dollar, five-year contract announced in early November.

Fluorine in the form of fluosilicic acid will be reclaimed by IMC from the processing of phosphate chemicals at its Bonnie, Fla., plant. It will be used by Kaiser Aluminum at its new plant at Mulberry, Fla., in the first stage of producing synthetic cryolite, a vital product in the reduction of aluminum.

Previously, fluorine compounds at Bonnie have been recovered and disposed of primarily in the form of insoluble fluorides with no market value.

Announcement of the IMC contract with Kaiser Aluminum concluded nearly two years of negotiations. Kaiser Aluminum will convert the fluosilicic acid into sodium silico fluoride at Mulberry and ship it to the company's Chalmette Works near New Orleans for final processing into synthetic cryolite.

Subsidence Book Published

The cause, effect, and prevention of subsidence resulting from coal mining operations are explained in an illustrated booklet just released by Pittsburgh Coal Co.

Purpose of the 8-page booklet is to provide a clearer understanding of subsidence; and to describe methods by which homeowners can work out a satisfactory solution for subsidence problems that may arise. Pittsburgh Coal operates mines in an area south of Pittsburgh that is being rapidly built up with residences. In much of the area the mineral rights have been separated from the surface rights and public relations problems arise when the coal company starts to mine under a real estate development.

In a review of Pittsburgh Coal Company's policy on mine subsidence, the booklet outlines the company's guarantee to pay for any structural damage caused by mine subsidence resulting from mining operations beneath homes where individual owners have paid for coal support. The practice of selling coal support as a preventive to subsidence has been in effect for many years, and according to the booklet, none of the homes with such support has suffered structural damage from mine-caused surface subsidence.

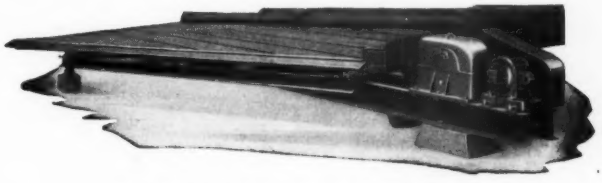
Prospective home builders are urged, where possible, to defer construction in areas where coal is yet to be mined.

"Coal left for support," the booklet states, "is lost forever and is an economic loss to the community and to the owner of the coal. For this reason, we believe it is to the interest of all concerned to defer building in areas where the coal is yet to be mined and encourage the selection of building sites in mined-out areas."

Where a home is already in existence, the booklet explains, it is possible to prevent subsidence by leaving supporting blocks of coal in a pattern and to an extent determined by engineering formula and proved by long experience. Coal blocks left in place comprise at least 50 percent of the original coal deposit.

The importance of coal to the Pittsburgh region is highlighted in the foreword of the booklet, which points out that in Allegheny and adjoining counties during 1957 the coal mining industry will produce about 52,000,000 tons which will generate an economic value to the region of over $1 billion.

The company plans to distribute the booklet to realtors, business associations, public libraries, colleges and universities, local government officials, and employes of the company.



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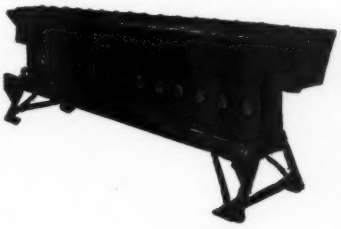
This efficiency is due in part to the shape of the deck, which has been designed to take advantage of the natural flow of the pulp. 75% more effective working riffles are thus trapping the values and fanning the bed out for accurate cutting. The result is exceptionally high grade concentrates, clean tailings and a reduced volume of middlings for recirculation. This in turn saves wear on the circulating equipment and makes room for more tons of new feed per day. Send for Bulletin 118-B.



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1958 COAL CONVENTION

Program Committee Named

JAMES C. GRAY
Chairman

PLANS for the 1958 Coal Convention of the American Mining Congress, to be held at the Netherland-Hilton Hotel in Cincinnati next May 5-7, are moving right along. James C. Gray, vice-president, Coal Operations, U. S. Steel Corp., last fall accepted the chairmanship of the Program Committee which is charged with the task of developing the Convention program. The Committee members represent a wide cross section of the coal industry, including operators from the major coal fields, from both deep and strip mining companies, together with a representative group of mining equipment manufacturers. Members of this important Committee are listed below.

Many new and in some cases startling advances have been made in mining and coal preparation techniques during the past year. These will be thoroughly covered in the many technical papers to be presented and discussed in Cincinnati. The important topics of health and safety, management problems, and maintenance will also be fully developed.

Competition for coal sales is increasing, and in turn the race for lower production costs has been stepped up. It comes as no surprise, therefore, that coal producers are exploring all possible means to improve mining techniques in an effort to maintain a price advantage over competitive fuels. The 1958 Coal Convention promises to unveil another important chapter in the constant battle to improve coal mining efficiency.

In addition to a fine technical program there will be two important luncheons. Both luncheon speakers will be men of national renown and will have special appeal to the coal mining fraternity.

The lighter side of the meeting will not be forgotten. On Monday night, May 5, there will be the famous Coal Miners' Party, and the Annual "Speechless" Banquet will be held on Wednesday night, May 7. An outstanding program of activities for the ladies will round out the Convention.

Now is the time to make plans to attend this important industry meeting. Mark your calendar now, reserving May 5-7, 1958, for the AMC Coal Convention in Cincinnati. A large attendance is expected and hotel reservations should be made immediately. Write directly to the hotel of your choice in Cincinnati.

Members of Program Committee — 1958 Coal Convention

JAMES C. GRAY, U. S. Steel Corp. *(Chairman)*
H. L. BEATTIE, Elk River Coal & Lumber Co.
G. F. BOWERS, Standard Oil Co. (Ind.)
M. W. BRANDT, Dorr-Oliver, Inc.
J. W. BROADWAY, Bell & Zoller Coal Co.
S. M. CASSIDY, Pittsburgh Consolidation Coal Co.
G. J. CLARK, Reading Anthracite Co.
R. J. CRAIG, Rochester & Pittsburgh Coal Co.
M. F. CUNNINGHAM, Goodman Mfg. Co.
E. T. DAY, U. S. Rubber Co.
R. E. DOUGHERTY, Tasa Coal Co.
O. A. GLAESER, United States Fuel Co.
A. G. GOSSARD, Snow Hill Coal Corp.
R. A. GRAY, Rome Cable Corp.
R. L. HALSTEAD, Allis-Chalmers Mfg. Co.
C. W. HAMILTON, Virginia Iron, Coal & Coke Co.
J. L. HAMILTON, Island Creek Coal Co.
W. D. HAMILTON, Saginaw Dock & Terminal Co.
H. J. HARPER, Eastern Gas & Fuel Associates
W. A. HASLAM, Winding Gulf Coals, Inc.
C. T. HAYDEN, Sahara Coal Co.
W. E. HESS, Jones & Laughlin Steel Corp.
JACK H. HOW, Western Machinery Co.
JAMES HYSLOP, Hanna Coal Div., Pittsburgh Consolidation Coal Co.
R. D. KETNER, General Electric Co.
R. E. KIRK, Consulting Engr.
HARRY LaVIERS, South-East Coal Co., Inc.
C. E. LAWALL, Chesapeake & Ohio Railway Co.
H. F. LAWRENCE, W. S. Tyler Co.
FRANK LEHECKA, U. S. Steel Corp.
L. E. MacDONALD, Bucyrus-Erie Co.
GORDON MacVEAN, National Mine Service Co.
E. MORGAN MASSEY, Omar Mining Co.
F. J. MONAGHAN, Olin Mathieson Chemical Corp.
W. H. MOORE, Susquehanna Collieries
C. R. NAILLER, Christopher Coal Co.
H. H. PANCAKE, ACF Industries, Inc.
R. G. PFAHLER, Berwind White Coal Mining Co.
E. R. PHELPS, Pittsburg & Midway Coal Mining Co.
L. A. PRICE, Union Wire Rope Corp.
DAVIS READ, Consulting Engr.
CAREL ROBINSON, Consulting Engr.
J. H. SANFORD, Ohio Brass Co.
W. C. SCHOTT, Stonega Coke & Coal Co.
P. L. SHIELDS, Spring Canyon Coal Co.
BRADLEY SPARKS, W. G. Duncan Coal Co.
R. H. SWALLOW, Ayrshire Collieries Corp.
E. B. WINNING, Republic Steel Corp.
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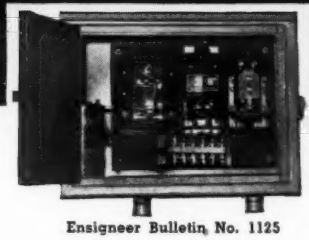
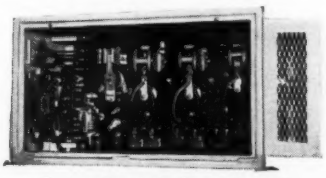


Ensigneer Bulletin No. 1125

ENGINEER SAFETY CONTROL FOR CONVEYOR SYSTEMS

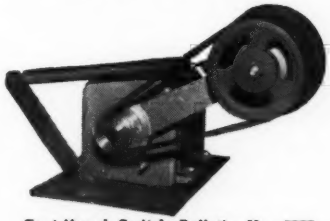
Consists of switch control and two contact wires stretched along conveyor line. Stops and starts belt conveyor when the two low voltage wires are pressed together. Time relay allows motor to come to complete stop before restarting.



Ensign Starter Bulletin No. 5390

ENSIGN STARTERS

For use with adjustable speed motor for belt conveyor service. Interlocked reverse switch prevents plugging—two speeds forward, half speed only in reverse. Full field in starting and speed-up for shuttle car dumping provided. Larger sizes with four steps acceleration available.



Centrifugal Switch Bulletin No. 1100

CENTRIFUGAL SWITCH

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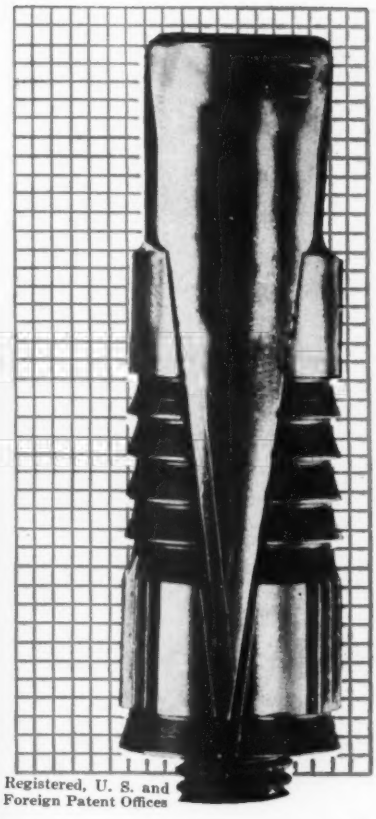

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Bolting results in less timber maintenance — improved ventilation — reduced waste handling — fewer fire hazards — wider openings — faster haulage and less material handling. Prove the benefits by making your own tests — samples of the PATTIN shells "D-1" (shown above) or the "D-2" will be furnished upon request.

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PATTIN expansion shells are available and serviced exclusively through The Colorado Fuel & Iron Corp., Denver, Colorado.

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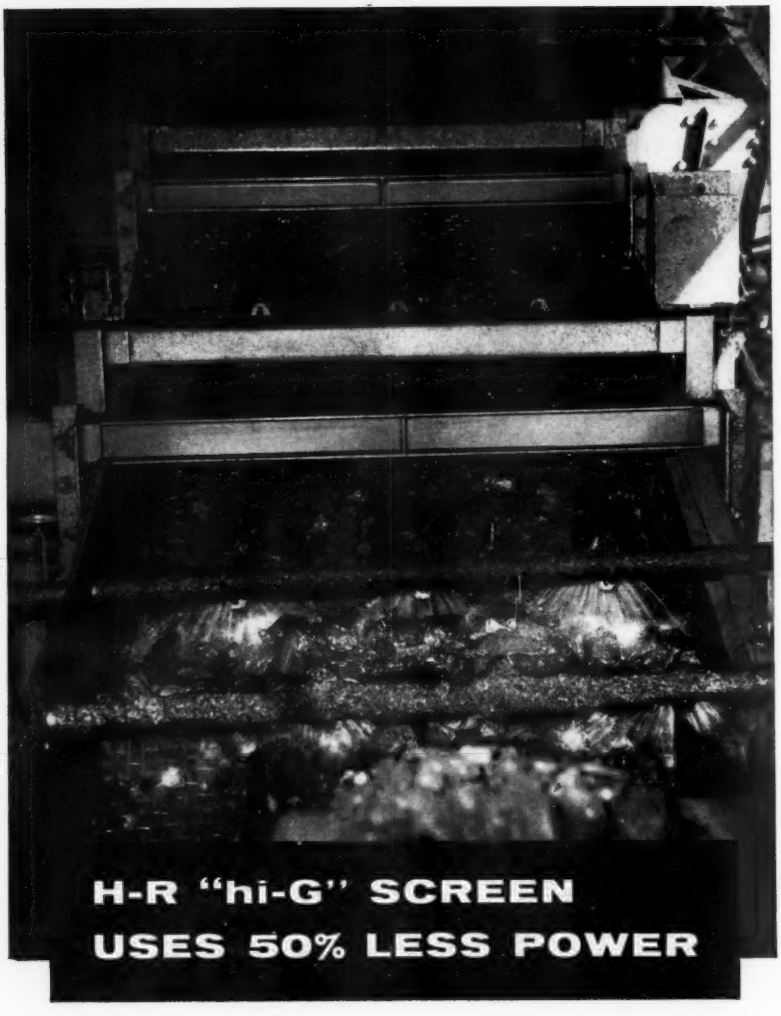

To reclaim coal from a 4-million ton waste pile, Black Star Anthracite Coal Company of Hazleton, Pa., uses a Hewitt-Robins bulk materials handling system which processes about 200 tons of material per hour. Coal is reclaimed, washed, sized, and recovered at the rate of 20 tons per hour.

An important unit in the system is Hewitt-Robins' "hi-G" Vibrating Screen, which operates on 50% less power. Savings up to $500 per year are realized with 6 x 28 ft. sizes. Readily accessible lower deck permits clear observation, easy spray pipe installation, and quick cloth changes.

To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Conn.

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INDUSTRIAL HOSE . . . VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

Education Committee Meets

On October 17, 18 and 19 the Vocational Training and Education Committee of National Coal Association met at the Ohio State University, in Columbus, Ohio. The Committee heard faculty members explain the work being carried out in the various departments and met with students in the Division of Mining.

New Furnace Tested

The Diamond Alkali Co. and Salem-Brosius Inc., both of Cleveland, announced recently that research has been "most promising" on a new furnace for refining metal ores with hot chlorine gas.

The new process, which was discovered by M. C. Irani, has resulted in the construction of a pilot plant and an experimental furnace at Painsville, Ohio.

The process involves the heating of the chlorine gas to a very high temperature and putting it to work as an ore reducing agency by encasing a graphite tube inside a steel tube with carbon black to insulate the graphite from the steel. The graphite tube acts as an electric resistance element in much the same manner as the carbon electrode in an ordinary electric furnace. As the corrosive gas is blown through the glowing hot tube, its temperature is raised to 4500°F. At this heat, chlorine is expected to combine with almost any metal, separating the metal from any other element combined with it.

Iron Ore Shipments

Great Lakes iron ore carriers this season carried 10,940,911 tons more than in 1956, according to the American Iron Ore Association. Shipments totaled 83,947,012 tons up to November 18.

Phelps Dodge in Canada

Announcement was made recently that the Phelps Dodge Corp. of New York has formed a Canadian exploration subsidiary and appointed W. A. Hutchison as general manager. This is the first move of the company into Canadian mining operations.

The new Canadian branch of Phelps Dodge will be known as Phelps Dodge Corp. of Canada, Ltd., and will conduct its own exploration as well as participate financially in other mining endeavors. The main office will be located in Toronto.

Mr. Hutchison resigned earlier this year from the managing directorships of Northspan Uranium and Preston East Dome mines. He directed the development and start of production at Rio Tinto of Canada's Elliot Lake uranium mines.

Guided Tour of Illinois Fluorspar Center

The American Institute of Mining Engineers, St. Louis Section, on October 11 had its first specially organized fluorspar field trip to Hardin County, Ill., the nation's largest fluorspar center.

Over 150 mining engineers, metallurgists, geologists, executives of mining companies and representatives of fluorspar consumers attended the field trip, inspecting on guided tours the major underground fluorspar mines and mills of the area. Representatives from the Illinois Geological Survey and the Missouri Geological Survey, and faculty and students from the University of Illinois and Southern Illinois University also attended.

Fluorspar mining company hosts were: Aluminum Company of America, Fluorspar Division; Ozark Mahoning Mining Co.; Minerva Oil Co., Fluorspar Division, and Rosiclare Lead and Fluorspar Mining Co., whose annual production accounts for a large percentage of America's total annual fluorspar production.

Coal Company Loses Tipple

The Crane Creek tipple of the American Coal Co. near McComas, Va., was destroyed by fire recently and resulted in a temporary closing of the mine. It was also announced that the loss of the tipple affected operation of other mines nearby. American Coal is owned by Pocahontas Fuel Co.

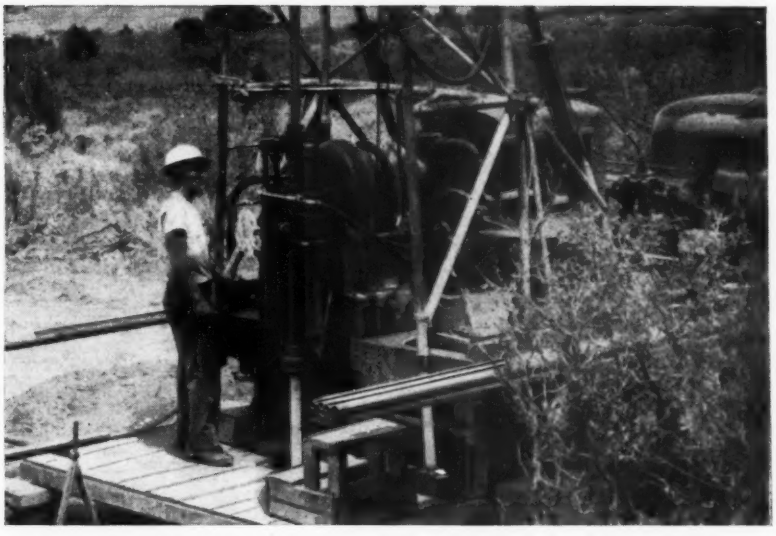
Origin of the fire was not known. In addition to the tipple, the fire damaged some of the conveyor equipment and a loaded railroad car which was under the tipple. The Crane Creek tipple was a complete coal cleaning and preparation plant which had been completely remodeled during the past two years. All new equipment had been installed in the tipple during the past few months.

African Project Outlined

Announcement was made recently in Montreal by Aluminium Ltd., that they plan to invest approximately $30 million in new hydroelectric and aluminum smelting facilities in French West Africa.

Construction of the new power and smelter projects is expected to take about six years with initial production of aluminum metal not before 1964 at the earliest, according to company officials. The power plant will have an installed generator capacity in excess of 700,000 hp with a firm power output sufficient to support an ultimate smelting capacity of 165,000 tons of aluminum annually.

Aluminium Ltd. is joined in the project by two French aluminium companies, Pechiney and Ugine.



One of the many drill rigs now in operation throughout the United States and overseas.

The most important primary phase of construction, roadbuilding or mining begins with foundation investigation or exploratory work from which it is desired to get complete information and best possible cores. In many instances, contractors make the mistake of bidding on work or taking a contract without complete knowledge of sub-surface conditions, or miners will start mining operations without first conducting a thorough exploration program, but successful contractors and mining men always investigate first to know how to quote in order to get the contract and still make a profit, and how to plan to have a successful operation. One of the most reliable organizations in America for furnishing this information and satisfactory cores is Sprague & Henwood, Inc. For more than seventy years it has been rendering satisfactory core drilling service throughout the United States and the world. Many of its customers have continuing contracts with Sprague & Henwood, Inc., because they know that they can be assured of the best in foundation investigation and core drilling service that can be found anywhere.

Sprague & Henwood, Inc., with its own manufactured field tested drilling equipment; its own manufactured "Oriented" diamond bits; its highly trained personnel; and its well trained and highly qualified supervision assure you of the best possible results obtainable.

Write to Sprague & Henwood, Inc., today for any information relative to test borings or core borings you desire, or for an estimate, giving complete information, and it will be on its way to you just as quickly as possible, without obligation to you.

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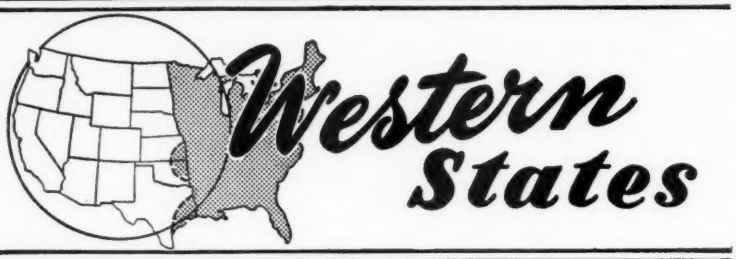

Inco Railroad Completed

In a ceremony attended by representatives of the Federal and Manitoba Provincial Governments, officials of International Nickel Co. of Canada, Ltd., and other guests, Premier Douglas Campbell of Manitoba drove the last spike into the 30-mile railroad spur linking Inco's Thompson mining area and the Canadian National Railways' Hudson Bay line at Sipiwesk, Manitoba, Can.

Symbolically, the ceremonial spike was fashioned from nickel. By 1960 nickel will start rolling over this spur from the new Inco project which will have an annual total capacity of 75,000,000 lb.

Ralph D. Parker, vice-president of International Nickel, who is in charge of the company's operations in Canada, pointed out that completion of the spur before the winter freeze-up permits Inco to expedite work on the project by allowing the company to move in the thousands of tons of materials and heavy equipment required to proceed with the development, generally without regard to weather conditions which often hamper other means of transportation. Most of the supplies and equipment already at the sites were brought in during the last freeze-up by tractor train.

He said that the new railroad facilities will also allow the movement of equipment which could not be transported otherwise into the area, such as heavy steel for the erection of permanent buildings, and grinding and crushing equipment.

Federal Adds to Idaho Holdings

Federal Uranium Corp., Salt Lake City, Utah, has acquired operating control of Idaho Lakeview Mining Company's Keep Cool and Hewer silver-lead-zinc mines adjoining Federal's Conjecture operation in the Lakeview area of Bonner County, Idaho. The agreement between the companies gives Federal control of a substantial part of the Lakeview district at the south end of Pend Oreille Lake.

Since taking over the Conjecture operation about a year ago, Federal has deepened the 1½-compartment inlined shaft from the 500 to the 700-ft level and has completed about 650 ft of drifting on the new lower horizon. The downward extension of one ore shoot has been exposed and another is expected to be hit a short distance ahead of the present face.

The new agreement with Lakeview entitles Federal to recover its exploration and development costs out of first profits. Subsequent earnings will be divided. In addition, Idaho Lakeview agreed to pay four-ninths of the cost of the Conjecture shaft from its share of operating profits.

Both the Keep Cool and Hewer mines are idle at the present time, but have been worked intermittently in recent years. Production has been milled in a 199-ton flotation plant and the resultant concentrates have been processed in the Bunker Hill smelter.

Forms Australian Subsidiary

Reynolds Metals Co., Richmond, Va., has formed Reynolds Pacific Mines, Ltd., as a wholly-owned Australian subsidiary with headquarters in Melbourne. The goal of the new company is to find and acquire substantial bauxite deposits and other raw materials which will ultimately justify the establishment of an integrated aluminum industry in Australia.

The subsidiary company was formed with an authorized capital of five million pounds (Australian) or about $11,250,000. Reynolds Metals, with its subsidiaries, operates mines in the United States, Jamaica, Haiti, British Guiana and Mexico.

Copper Outlook

At ceremonies dedicating the Africana mine at Santiago, Chile, on October 25, Roy H. Glover, chairman of the board of The Anaconda Co., predicted that the copper industry will shortly return to the situation where sufficient production, and not sufficient demand, is the problem—and that this should naturally be followed by rising prices. Glover said it was his belief that during the past 12 months the industry has been going through a period of readjustment which has carried prices to a level that makes it impossible for a substantial segment of the copper mining industry in the United States and in Chili to operate profitably. He pointed out, though, that during the first eight months of 1957 there has been a consumption in excess of U. S. production and imports of an amount greater than 142,000.

Nevada Gold Property Worked

The Round Mountain Gold Dredging Corp., which has a long-term lease on property of Nevada Porphyry Gold Mines, Inc., in the Round Mountain district, north of Tonopah, Nev., is proceeding with operations. Excavation of overburden and placer deposits has been contracted to Morrison-Knudsen Co., which is now removing overburden at the rate of 50,000 cu yd per week.

The company plans to renovate a mill erected several years ago for processing extensive deposits of placer material, and operations are scheduled to start March 1, 1958, at the rate of from 250,000 to 300,000 cu yd per month.

The project will involve the removal of some 33,000,000 yd of overburden and nearly 39,000,000 yd of mill feed.

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FRANK COOLBAUGH

PROGRAM COMMITTEE CHAIRMAN APPOINTED FOR SAN FRANCISCO MINING SHOW

FRANK COOLBAUGH, vice-president of Climax Molybdenum Co., has accepted an invitation extended in September by Howard I. Young, AMC president, and John D. Bradley, chairman of the Western Division, to serve as National Program Committee Chairman for the 1958 Metal Mining-Industrial Minerals Convention and Exposition of the American Mining Congress. September 21 to 25 are the dates for this greatest mining show of the year, which will be held in San Francisco's Civic Auditorium and new Civic Center Exhibit Hall.

A nation-wide committee under Mr. Coolbaugh's leadership will consider hundreds of program suggestions from mining men throughout all branches of the industry and all parts of the country. A comprehensive and balanced program will be developed for the meeting—embracing the latest on all aspects of mining, from national mineral policies to the newest operating techniques.

The Exposition, sponsored by the Manufacturers Division of the American Mining Congress, gives promise of being the largest and finest showing of mining equipment ever held in conjunction with these meetings. Exhibit facilities in San Francisco have been vastly improved. With the addition of the new 90,000-sq ft building at the Civic Center, the available exhibit space will be about double what it was at the 1954 Exposition in San Francisco. Every type of modern equipment used to produce metals and minerals will be shown by the nation's leading mining manufacturers.

A full program of entertainment and trips will be arranged by the various committees under the general chairmanship of "Jack" Bradley. The committees will leave no stone unturned in their efforts to make this year's meeting the most worthwhile and enjoyable ever. Combine this with the many fascinations of the city of San Francisco and you will make up your mind *now* to be on hand next September.

New Civic Center Hall in San Francisco—under construction. Connecting with the Civic Auditorium, it will be completed before midyear and ready for the AMC Mining Show in September

Deep Exploration Begun in Coeur d'Alene

American Smelting & Refining Co. has started a new deep exploration project in the Coeur d'Alene mining district of Idaho.

Workmen already have started driving an exploration lateral easterly from the 3070-ft level of the company's Page lead-zinc mine west of Kellogg. The lateral will be about 5700 ft long and with crosscuts and diamond drill holes will explore an area between the Page and Bunker Hill mines.

The East Page project will take an estimated five years to complete. Work now is on a one-shift basis but will be stepped up later.

Kennecott Cutting Personnel

Layoff notices have been given to approximately 180 employes of the Chino Mines Division of Kennecott Copper Corp. in connection with the company's current program to reduce its costs of operation, W. H. Goodrich, general manager, recently announced.

He emphasized that the layoffs are only one part of our cost cutting campaign. The company intends to make substantial savings by eliminating waste and in streamlining methods for more efficient operation.

Goodrich said the layoffs were initiated after a study of jobs through the company's mine at Santa Rita and mill, smelter and power plant in Hurley and that the jobs which were eliminated were found not to be necessary.

"This cost reduction program," Goodrich said, "was initiated to enable the company to meet competition in the copper market. We must be able to sell our copper at the price the customer is willing to pay or go out of business."

Chrome Company Formed In Utah

A new company, Western Chrome, Inc., Salt Lake City, Utah, has been formed to develop chromite mines in Siskiyou County, Calif. President of the company is J. Bracken Lee, former Republican Governor of Utah.

The firm plans to convert a 150-tpd gold mill to a chromite ore concentrator and to explore and develop mines.

Antarctic Minerals Survey

Announcement was made recently that geologists from New Zealand are planning a survey of antarctic mineral resources next winter. The announcement was made by the United Nations Educational, Scientific and Cultural Organization.

The geologists plan to make use of the transport and bases organized in Antarctica for the International Geophysical Year and will concentrate their studies on the Ross dependency and the northern part of South Victoria Land. They will work from the joint New Zealand-United States base at Cape Hallett and map the little known territory of the Ross dependency and seek to establish the geological connection between east and west Antarctica.

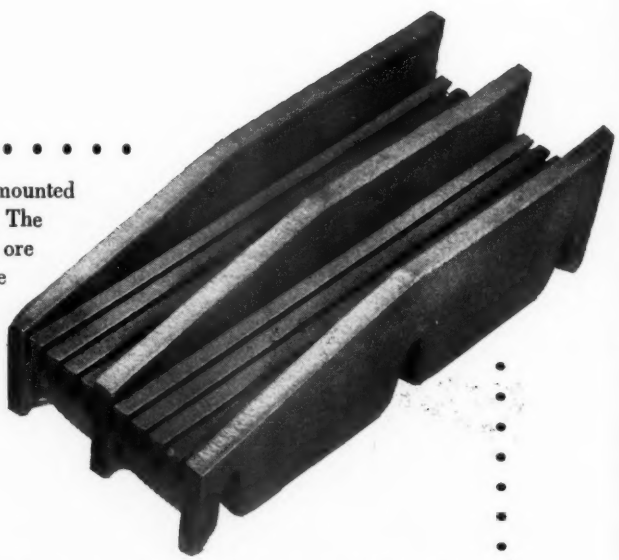
New Uranium Mill Contract

Homestake Mining Co., San Francisco, has signed a contract with Utah Construction Co. for a uranium mill near Grants, N. M. The 1500-tpd mill will be operated by Homestake-Sapin Partners.

BIG BOULDERS HIT THE SKIDS!

. . . *not the screen!*

There's nothing that can compare to Hendrick skid bar mounted Wedge Slot Screens for heavy-duty metal mining. The rugged skid bars protect wedge slot profiles from large ore chunks . . . greatly reduce wear caused by abrasion. The C-12 profile bars have thick parallel head flanges to maintain uniformity of openings. Designed for long service life and excellent drainage, C-12 bars are $^{12}/_{64}$" wide . . . slots run the whole length of the screen. Write for more information.



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SEE OUR CATALOG IN SWEET'S

Idaho Mercury Mine Restored

Systematic exploration, careful planning and use of low-cost, open-pit mining have restored the Idaho Almaden mercury mine near Weiser, Idaho, to profitable operation, according to a Bureau of Mines technical report released by the Department of the Interior.

The mine had been closed in December 1942 when the grade of ore declined to four lb of mercury per ton, then regarded as the cutoff point. The report tells how the Rare Metals Corporation of America, which acquired the property from the former operator, is profitably mining and treating ore averaging 3.5 lb of mercury per ton.

The ultimate cutoff point, when facitities installed by the company have been amortized, is now estimated at two lb per ton of ore.

Constant sampling, separate blasting of waste and ore, and operation of the largest rotary kiln furnacing mercury in the United States are among the techniques described.

A copy of the report, I. C. 7800, "Mining, Processing, and Costs—Idaho Almaden Mercury Mine, Washington County, Idaho," can be obtained by writing the Bureau of Mines, Publications—Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

Nevada Plant to Produce Tungsten Carbide

Nevada Scheelite Division of Kennametal, Inc., has ceased all mining and milling operations at its property in Mineral County, Nev., but is about to begin manufacturing tungsten carbide. Initial capacity of the plant, employing some 20 men, will be about 20,000 lb of tungsten carbide per month.

Concentrates produced from mining and milling operations prior to closure of the mine and mill will be used in the production of tungsten carbide, but some tungsten concentrates are being purchased.

The company indicates that the mine will be kept on a stand-by basis in case future needs dictate its reopening.

Utah Phosphate to Be Developed

Stauffer Chemical Co. and affiliated San Francisco Chemical Co. have scheduled exploitation of one of the largest single phosphate deposits in the Western Hemisphere, 15 miles north of Vernal, Utah.

The measure and speed with which this large deposit of medium-grade phosphate rock will be developed depends on a number of factors. But Stauffer is definitely making its move into the elemental phosphorus field, according to Elwood I. Lentz, vice president of Stauffer's affiliated Western Phosphates, Inc.

Copper Exploration in Philippines

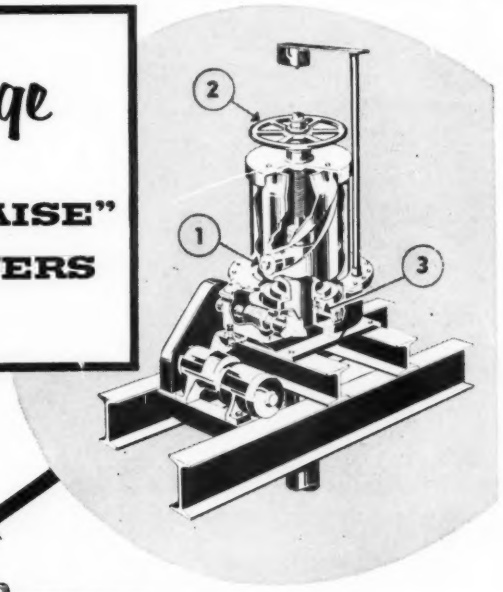
Atlas Consolidated Mining & Development Corp., a copper producer in the Philippines, has entered into an ore development contract with Newmont Mining Corp.

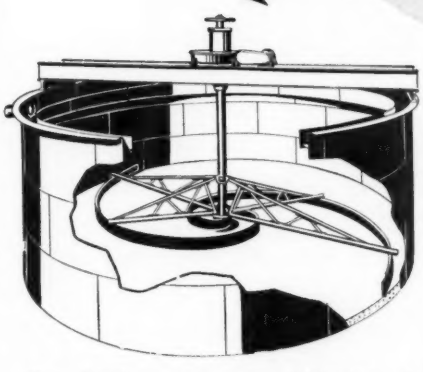
Newmont will develop certain known copper-ore areas in the Philippines and explore for and develop new ore bodies. The number of shares which Atlas will pay Newmont will not exceed 2,625,000 ordinary shares out of a total of 18,325,000.

Atlas stockholders also approved a 35 percent investment by the corporation in the Phelps Dodge Copper Products Corp. of the Philippines. Phelps Dodge Corp. of New York owns 51 percent of the Philippine concern, with the remaining 14 percent controlled by other Philippine interests.

Hardinge

"AUTO-RAISE" THICKENERS





...for all clarifying, thickening and de-sliming operations.

For flotation concentrates thickening ahead of filtering—or for tailings disposal or reclamation, Hardinge Thickeners provide:

1. "Auto-Raise" to avoid lost production from overloads.
2. Manual or power raise to supplement "Auto-Raise."
3. Replaceable ring-type ball bearing support for rotating mechanism.
4. Spiral rakes for maximum underflow density.

Also available are froth rakes for froth-free overflow and superposed type tank construction for minimum floor space and building economy. Complete specifications on request. Bulletin 31-D-52.

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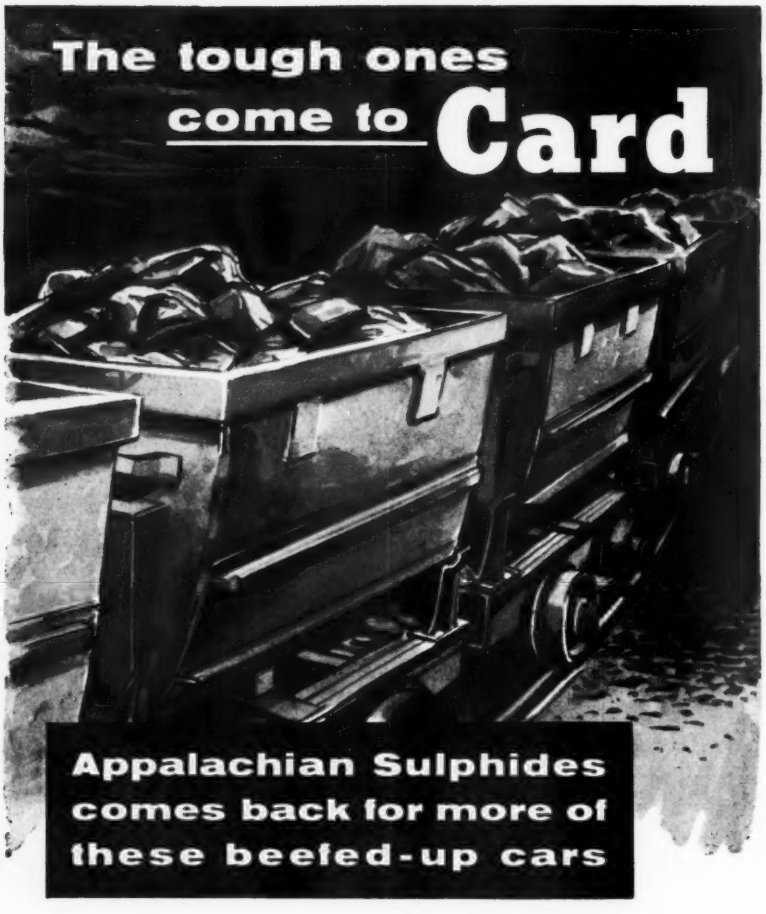
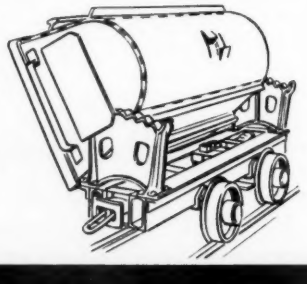


Within a five year period Appalachian Sulphides, Inc., (formerly Vermont Copper Co.) has purchased 42 Card Rocker Dump Cars on four successive orders. The heavy sulfide ore is side-loaded by rocker-shovel, placing unusual strain on the cars. Card engineers worked closely with the customer to produce a 40 cubic foot car which does not break down under this service.

The result is a car body of low-alloy high-strength steel plate, mine rail reinforced, and a frame nearly three times standard strength with proportionately heavy rocker pedestals. It includes the new Card safety locks. Our engineers are always willing to work with you for the right solution to some particular haulage problem. Standardize your haulage with an economical Card design.



C.S. Card Iron Works Co.
2501 WEST 16th AVE.,
DENVER, COLORADO

Montana Alumina Plant Progresses

Anaconda Company's pilot plant for recovering aluminum from Moscow, Idaho, area clays will be completed sometime after the first of the year. The firm is now making a test excavation and shipping clay to Anaconda, Mont., where it will be stored for future testing in a pilot plant under construction there.

Company officials previously announced that the pilot plant will cost $1,000,000 and that, if results are satisfactory, a full-scale alumina-from-clay recovery plant will be built in the Moscow area.

To Deepen Idaho Shaft

Clayton Silver Mines is planning a $165,000 shaft-deepening project at its Custer County, Idaho, property. Most ore above the 400-ft level has been mined out, but reserves minable from the 500-level are expected to permit capacity milling of about 3000 tons monthly for the next four to six years.

Five Spokane Uranium Firms May Merge

Directors of Dahl Uranium Mine, Inc., Big Smoke Uranium, Inc., Universal Mining Corp., Far West Mines, Inc., and Monida Mines have approved a proposed merger agreement. If stockholders approve the merger proposal, assets of the five firms will be exchanged for stock in Spokane National Mines, Inc., which recently filed articles of incorporation at Carson City, Nev.

The new firm, with private financing, would undertake to further explore and develop the holdings of the five companies, concentrating first in the Spokane Indian Reservation of Washington.

Acquires California Quicksilver Mine

Rare Metals Corporation of America has acquired controlling interests in the Altoona quicksilver mine near Dunsmuir, Trinity County, Calif., according to M. H. Kline, vice-president and assistant general manager. He said that the interests were acquired from Bert C. Austin, an official of Idaho-Maryland Mining Co., and L. C. Smith. Proved reserves, he said, were in the 40,000-ton area with quicksilver running about 15 lb per short ton.

Japanese Will Buy Canadian Copper

A contract for sale of some five million dollars worth of British Columbia copper concentrates in the next two years has been negotiated between Cowichan Copper Co., Ltd., and Japanese interests. Oswood G. MacDonald, Cowichan president, said the contract will involve the entire output of the company's Vancouver Island mine.

Manufacturers Forum

Mine Lighting System

PERMISSIBLE FLUORESCENT lighting systems for working areas up to the face in coal mines are being marketed by Femco, Inc.

Known as Mine-Lite systems, they have U. S. Bureau of Mine approval for gassy atmospheres at the working face. Lamp units reportedly are inherently safe and cannot explode or cause fires.

Each lamp unit, which contains two fluorescent tubes, a reflector, a heavy clear plastic tube, an aluminum cup with handle, and a sealed-in ballast in an aluminum base, weighs 12 lb. Operation is for 230 volt a-c. Forty lamp units containing 80 fluorescent tubes are said to use ten amp.

For additional information write Femco, Inc., Irwin, Pa.

A-C Motor

A SYNCHRONOUS INDUCTION motor built in the same NEMA frame size on a standard motor of equal horsepower has been announced by the Louis Allis Co. Called the Syncro-Spede, this motor reportedly accelerates as an induction motor but runs at exact synchronous speed. It is manufactured in ratings from 1 to 100 hp in any enclosure type and can be foot-or flange-mounted. It is designed for horizontal or vertical mounting. For complete information, request bulletin No. 1900 from Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

Drill for Blast Holes

THIS PERCUSSION TYPE Mole-Dril drills 4¾ to 6½ in. blast holes for open-pit mining. Two models are currently available, the AM-4 and AM-6. Model AM-4 weighs 98 lb, is 35½ in. long, has an outside diameter of four in., and uses a 4¾-in. bit.

Model AM-6 weighs 200 lb, is 39 in. long, has a 5¾ in. outside diameter, and uses a 6½-in. bit.

According to the manufacturer, the Mole-Dril adds power and versatility to rotary type drill rigs. Whenever hard formations are encountered, the Mole-Dril may be attached to the drill stem in place of the rotary bit. The drill stem conducts the compressed air supply to and rotates the drill. A tungsten carbide insert bit is attached to the tappet, thereby becoming an integral part of the drill. As a result, they explain, the Mobil-Dril gives maximum drilling efficiency, regardless of depth. The drill rod between the drill and bit is eliminated.

A direct air stream, at full line pressure, is directed through the bit to keep the hole face clean. Exhaust air from the drill is directed upward through ports midway up the drill, giving an assist in blowing cuttings up the hole.

Additional specifications and application information may be obtained from Gardner-Denver Co., Quincy, Ill.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Bucket Positioners

AUTOMATIC bucket positioners for the No. 955 and No. 933 Traxcavators have been announced by Caterpillar Tractor Co., Peoria, Ill.

The bucket positioning feature is said to automatically move the bucket tilt control level from the tilt-back position to the hold position when the bucket reaches a preset digging angle.

The adjustable linkage provided with the bucket positioner allows the bucket to be positioned at any point between an approximate five-degree digging angle and the three-degree tilt-back angle.

For No. 955 and No. 933 Traxcavators already in operation, field change-over kits are available.

Truck

DESIGNED FOR MINES, the Getman KD-2 truck was developed by Getman Brothers of South Haven, Mich. It has the following dimentions: overall length, 122 in.; overall width, 60 in.; box height at tail gate, 47 in.; turning radius, 96 in.; wheel base, 83 in.; box capacity, 40 cu ft; carrying capacity, 2½ tons.

Diamond Drill

A 37 LB ROTARY DRILL has been announced by Wink Corp., 1518 North 117th St. Milwaukee 13, Wis. Called Winkie Diamond Drill, the machine is said to have coring capacities up to 200 ft depths, obtaining 15/16-in. rock cores. Larger core diameters up to six in. are handled, however, to

lesser depths according to the diameter of the core to be taken. An overhead drive principle allows up to ten-ft strokes without rechucking the drill rod. A 5¼-hp, 2-cycle, gasoline engine with a vacuum carburation system reportedly allows continued all angle drilling. Among the unit's applications, according to the manufacturer, are marine drilling, rock and concrete coring, blast hole drilling and soils sounding.

Gamma-Ray Well Logging Probe

A SCINTILLATION-TYPE gamma-ray well logging probe, Model SP-190, has been announced by Mount Sopris Instrument Corp., 1320 Pearl St., Boulder, Colo. The SP-190 characteristics reportedly are such as to provide the maximum in stratigraphic information. The output signal is in the form of a d-c voltage suitable for driving a conventional millivolt-type recorder and only a single conductor and ground are required to transmit the signal to the surface. Other information in the form of an alternating or pulse signal may be simultaneously transmitted over this same conductor. Thus, according to the company, the SP-190 has been used in simultaneous resistance and gamma-ray logging and for a gamma log with a collar counter utilizing a single conductor.

Crawler Tractor Sprockets

THE ELEMENT BORON is being used to increase the life of crawler tractor sprockets, according to Caterpillar Tractor Co., Peoria, Ill. Marketed under the trade name Boralloy, these sprockets are now standard equipment on Caterpillar D8 and D9 Tractors. Boralloy replacement rims are available for D8 sprockets. Said to represent the first commercially successful attempt to produce boron-bearing cast carbon steel by the acid open hearth process, the Boralloy sprocket was developed as a cooperative research project between Caterpillar and Harrison Steel Castings Co., Attica, Ind.

Protects Storage Piles

A SPRAY has been developed which blankets and protects outdoor storage piles of bulk materials against all types of weather conditions for periods up to a year or more, according to the Johnson-March Corp., Philadelphia 3, Pa.

The product, called Permaspray, is a colloidal suspension in water of a special chemical which reportedly forms a water-resistant film when exposed to air and hardened. It is said to be suitable for coating stock piles of coal, ores, coke breeze, flyash, sulphur, sand, paint pigments, waste, and all types of materials in dead storage regardless of composition or particle size.

Oil Hydraulic Circuit Tester

A PORTABLE oil hydraulic circuit tester, Model PT-100-B, has been developed by the Schroeder Brothers Corp., McKees Rocks, Pa. Weighing 19 lb, it measures temperature, volume and pressure and pinpoints a faulty hydraulic pump, valve or circuit. The tester is claimed to be ideal for use on hydraulic construction and earth moving equipment and for use in plants and as a header on a shop test bench.

Filter Holders for Air Sampler

A LARGER filter holder is now optional equipment with the Staplex Hi-Volume Air Sampler. Made of stainless steel and aluminum, it consists of a mounting collar extended to a rectangular opening. The mouth, protected by a screen, accomodates 6 by 9-in. and 8 by 10-in. filter papers.

According to the Staplex Co., Air Sampler Division, Brooklyn 32, N. Y., the sampler was originally designed by the New York Office of the Atomic Energy Commission and has been used by Government and industry to detect and measure airborne radioactive particles, dust, smoke and smog, mine and factory air hazards and for research and testing.

Scraper

A FOUR-WHEEL UNIT, called the No. 435 Lowbowl Scraper, has been announced by the Caterpillar Tractor Co., Peoria, Ill. It replaces the Caterpillar No. 70 Scraper in the company's line.

The low silhouette of the No. 435 reportedly allows material to enter the scraper with a minimum of lifting effort and material-to-material friction. On a comparative basis, the No. 435 Scraper offers 38.6 sq ft of bottom area a 31.9 sq ft for the No. 70. This increase helps to provide the new unit with a struck capacity of 13 cu yd, an increase of 27 percent over its predecessor model. It can transport 18 cu yd of heaped material.

To assure thorough, positive ejection, according to the manufacturer, the No. 435 is designed with an ejector of increased height, and greater apron opening. Protection against fouling of the draft arms due to rock spillage over the scraper sides is afforded by the incorporation of rock guards on the new unit.

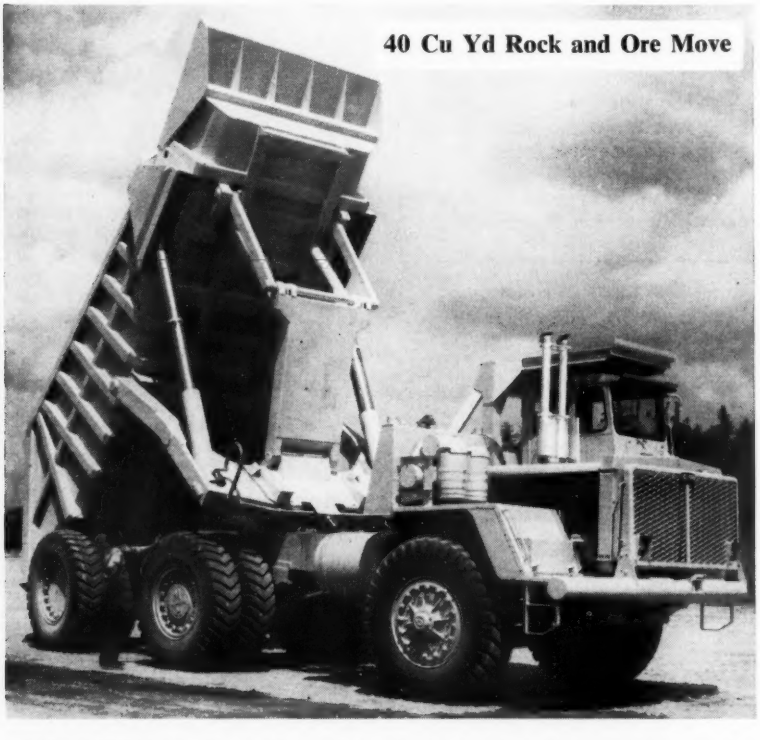
Power Transmission Belt

A COMBINATION OF TWO MATERIALS—polymer and a chrome tanned leather—the belt is called Extremultus. The polymer is the tensile member and the leather is the friction surface. According to the manufacturer, the belt will not slip or stretch, will operate at speeds up to 24,000 fpm and horsepowers up to 6000, will operate at ratios up to 20:1 and arcs of contact as low as 90° and will operate efficiently under shock loads up to seven times the normal running load. For more information contact Extremultus, Inc., 405 Lexington Ave., New York 17, N. Y.

Whiteprinting Machine

FOR PROCESSING AMMONIA TYPE diazo whiteprints, the Revolute Star offers production speeds up to 45 fpm with automatic separation. Front and rear suction tanks provide separation of original and sensitized material. A solenoid pump reportedly assures accurate metering of full strength ammonia and is synchronized with machine drive for automatic operation. The unit has a 4000-watt light source. Write for complete details to the Paragon-Revolute Corp., 77 South Ave., Rochester 4, N. Y.

40 Cu Yd Rock and Ore Move



MEASURING 41 FT 11 IN., one of the largest rear-dump semi being built today is now coming off the production line, according to Kenworth Motor Truck Co. in Seattle, Wash. It is the 803-B with a rated pay load capacity of 64 tons or 40 cu yd struck.

The 803-B has a gross vehicle rating of 228,000 lb, with front axle capacity of 50,000 lb and rear axle capacity of 100,000 lb. Powered by a single 12-cylinder diesel engine, it will be offered with either the 400 or the 600-hp version of this engine. It has a turning radius of 37 ft with a turning angle of 30°. Tractor wheelbase is 168 in.

Blast Hole Drill

A ROTARY blast hole drilling rig, Model 125 has been announced by Joy Manufacturing Co., Oliver Bldg., Pittsburgh 22, Pa. It is equipped with Duo-Flow, a feed mechanism consisting of a combination mechanical and high torque reversible hydraulic motor and air compressor. The 125 also has an oil bath type rotary table, double drum type drawworks mounted on a common shaft, hydraulically raised and lowered mast plus Proximity Controls which reportedly give the operator complete control of the rig without moving from the operator's position. The rig is either truck or trailer mounted with power provided by truck engine or auxiliary power units.

Centrifugal Pumps

A LINE OF HIGH-SPEED, high-head centrifugal pumps for general water service has been announced by Gardner-Denver Co., Quincy, Ill.

The Model BH pumps are available in four sizes—a one-in. model with capacities to 150 gpm, and 1½-in. model with capacities to 220 gpm, a two-in. model with capacities to 440 gpm and a three-in. model with capacities to 520 gpm.

Features claimed include stainless steel shafts, oil-lubricated heavy-duty ball bearings, mechanical seals, accurately contoured casings, and hydraulically balanced bronze impellers.

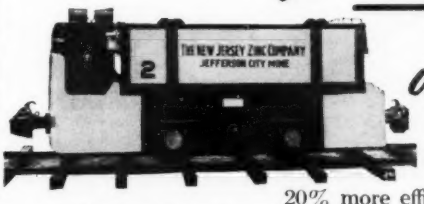
Scaler

FOR PRECISE MEASUREMENTS of all radioactive materials and electrical impulses, the Universal Scaler (or Scaler-Ratemeter) reportedly features a wide choice of optional slide-out plug-in sections that allows a customer to order an instrument built to his own needs. It presents information in all forms of display. Obsolescence is said to be eliminated. As requirements increase, one changes or adds plug-in sections that contain the desired features. Write for Bulletin N-17 to Nucleonic Corporation of America, 196 Degraw St., Brooklyn 31, N. Y.

Lubricant

FOR HANDY LUBRICATION OF OPEN GEARS and sliding surfaces, the Whitmore Mfg. Co., of Cleveland 4, Ohio, is packaging its Liquid Gear Composition in a 16-oz push-button aerosol container. Whitmore's Handi-Lube Liquid Gear Composition is prayed on pressure side of surface from a distance of 12 to 18 in. This film of lubricant reportedly eliminates harmful metal-to-metal contact and increases gear life by putting the wear on the lubricant instead of the metal. Whitmore's lubricants are said to be water-proof.

There's a Good Reason... NEW JERSEY ZINC Co. uses Greensburg storage battery locomotives



7T Monitor-type

3T Monitor-type

AUSTINVILLE, VA., MINERAL, VA., FRIEDENSVILLE, PA. and JEFFERSON CITY, TENN.

THEY are rugged, dependable battery locomotives which are up to 20% more efficient and give longer battery life than other comparable locomotives. Well-fitted for the job, Greensburg locomotives have double equalizers exerting equal pressure on all 4 wheels for greater tractive effort, better braking, riding and roadability. Available in single or double motor drive with drum, cam or magnetic contactor type controller.

Send us your haulage problems

GREENSBURG MACHINE CO.
GREENSBURG, PA.

—*Announcements*—

Election of **Jeff C. Clay** as vice-president of engineering for **The Long Company**, Oak Hill, W. Va., has been announced. Before joining Long in 1954, Clay was chief draftsman with the **Link-Belt Co.**

Frank W. Jenks, formerly executive vice-president of **International Harvester Co.**, has been elected president of the company. He succeeds **Peter V. Moulder** who retired.

Joseph P. Olds has recently been named Anthracite Sales Engineer for **Wilmot Engineering Co.**

Dresser Industries, Inc. of Dallas, a leading producer of equipment and technical services for the oil, gas and chemical industries has acquired **Gardner-Denver Co., Quincy, Ill.** Gardner-Denver will be combined with four present subsidiaries of Dresser to form a new wholly owned subsidiary of Dresser Industries, known as Gardner-Dresser Co. **G. V. Leece**, president of Gardner-Denver will be chief executive officer.

William L. Wearly was elected president of **Joy Manufacturing Co.** at a meeting of the board of directors on October 30. **The** election came as a result of the resignation of **John Lawrence. A. B. Drastrup** was elected executive vice-president to fill the position formerly held by Wearly.

W. L. Wearly

A. B. Drastrup

Starting his career with Joy in the operating department of the company's Franklin, Pa., plant 20 years ago, Wearly later became vice-president in charge of sales and for the past two years has been executive vice-president. Drastrup has been manufacturing vice-president and assistant to the president.

CATALOGS & BULLETINS

AIR FILTRATION. *Flanders Filters, Inc., P. O. Box 718, Riverhead, Long Island, N. Y.* Entitled, "Flanders Air-pure Filters for Science and Industry," the booklet describes the company's ceramic filters for use up to 2300° F. Supply-Air purification units for civil defense (bomb shelters) and Expansible Filters. A filter selection chart is included.

MOTOR SCRAPER. *Allis-Chalmers Mfg. Co., Construction Equipment Division, Milwaukee, Wis.* Performance and design features of the TS-160 Motor Scraper are given in catalog MS-1226. Photographs, illustrations and specifications help tell the units design and construction story.

CENTRIFUGAL FANS, *Westinghouse Electric Corp., Sturtevant Division, Dept. T-406, 200 Readville St., Hyde Park, Boston 36, Mass.* Catalog 1121 describes airfoil blading for all-purpose applications in a line of centrifugal fans (Series 8000) covering every requirement up to 700,000 cfm and up to 16¾-in. total pressure. Selection charts are included. Block dimensions and fan arrangements are also detailed.

SCREEN. *Nordberg Manufacturing Co., Milwaukee 1, Wis.* Entitled "Symons Vibrating Rod Deck Screen," Bulletin 265 describes the ten sizes of the screen, ranging from three to six ft in width and six to ten ft in length. The multiple screening action and patented screening surface of the Rod Deck Screen are two of the features which receive special attention in the brochure.

SINKER DRILLS. *Sales Promotion Dept., Le Roi Division, Westinghouse Air Brake Co., Milwaukee, Wis.* Hollywood models are used in five pieces of literature to illustrate the ease of operating a line of shock absorbing handle drills manufactured by Le Roi. The torsion rubber-cushioned handles are said to reduce operating vibration by 55 percent without loss of bit impact and can be adjusted to suit the operator.

SHOVEL LOADER, TRACTOR AND BULLDOZER. *Joy Manufacturing Co., Oliver Bldg., Pittsburgh 22, Pa.* Entitled "Joy Crawler Equipment," the brochure describes the JMT-7 Mining Tractor, JSL-7 Mining Loader and JMD-7 Mining Dozer. The JMT-7 can be equipped with a host of attachments for many applications in the mine. It also assumes the important function of serving as a chassis for the Joy Shovel Loader and Joy Mining Dozer.

INDUSTRIAL TOWING TRACTORS. *Buda Division, Allis-Chalmers Mfg. Co., Milwaukee, Wis.* Engineering design and construction features, along with operating data and specifications covering the TG-45 and TG-50 industrial towing tractors, are outlined in bulletin BU-337A.

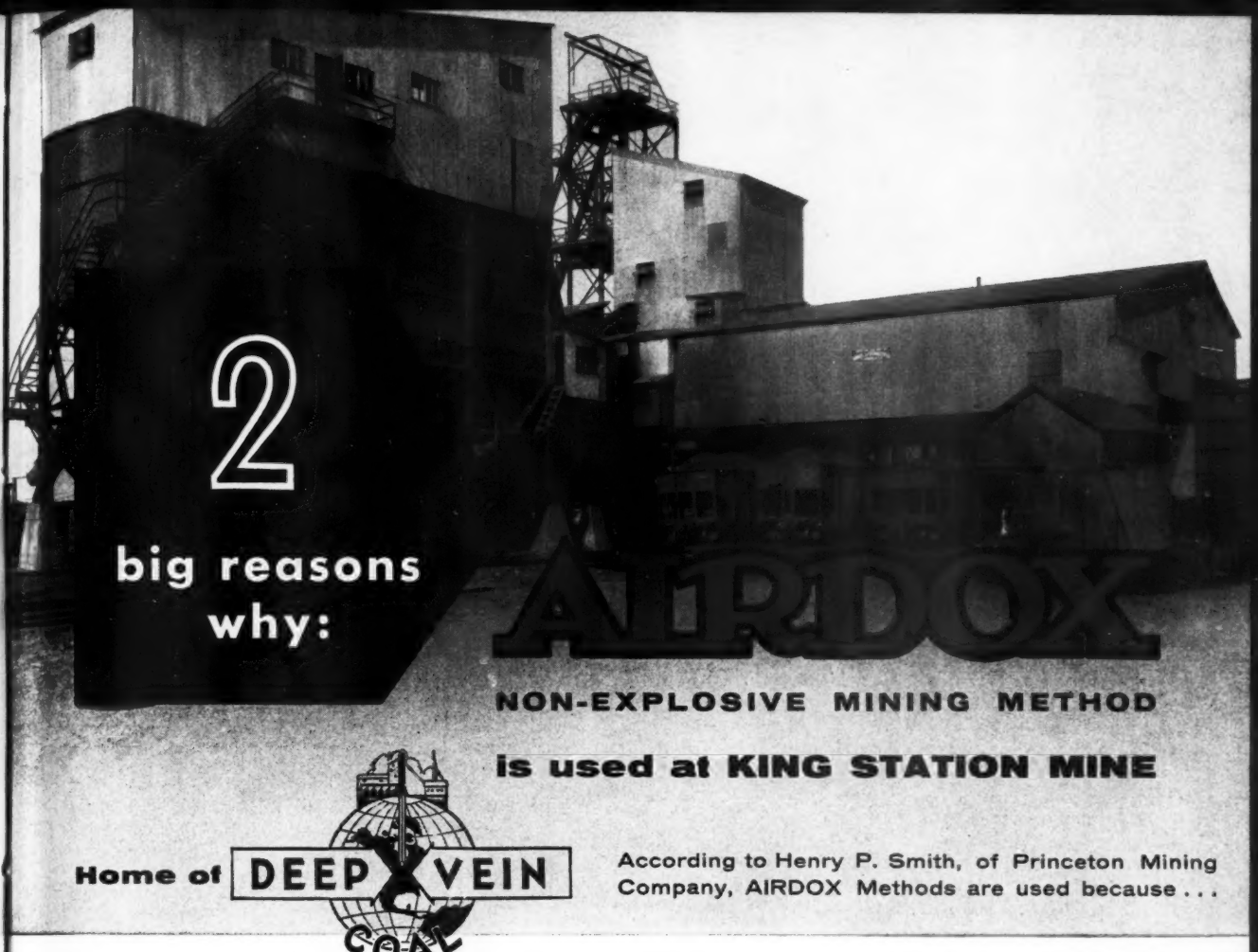
HYDRAULIC HOSE FITTING MAKE-UP. W. D. Wynant, Tube & Hose Fittings Division, Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio. A card (Bulletin 4433B1), for hanging on the wall, gives instructions with pictures of the two simple steps in assembling non-skive Hoze-lok fittings to rubber covered, wire braid hose.

CAN YOU BE SURE? *Advertising Division, Caterpillar Tractor Co., Peoria, Ill.* This two-color booklet, Form No. DE760, explains why the manufacturer's own replacement parts are recommended for best performance and service life. Drawings and cutaways show the individual characteristics of pistons, rings, pins and cylinder liners with emphasis on their physical and metallurgical design features.

SEAMLESS STAINLESS PIPE AND TUBING. *General Sales Offices, Tubular Products Division, Babcock & Wilcox Co., Beaver Falls, Pa.* Engineers, buyers, estimators and others responsible for the specification and procurement of seamless stainless pipe and tubing will be interested in the comparative price data furnished on Technical Data Card 188. This card furnishes the analysis details and comparative price ratios of 33 seamless stainless grades using Type 304 (18-8) as a base.

MOBILE MACHINE SHOPS. *Davey Compressor Co., Kent, Ohio.* Illustrated with photos and blueprints, bulletin E-208 describes truck-mounted repair units. Shop assemblies vary from relatively simple items of power equipment to vast collections of tools and accessories. The latter are said to be complete maintenance and repair depots "on wheels." Basic units are Davey Air compressors and power and welding generators. These are driven direct from the truck engine through a Davey Heavy-Duty Power Take-Off. Shops can be mounted on practically every make and model of truck.

Index to Advertisers



2 big reasons why:

AIRDOX

NON-EXPLOSIVE MINING METHOD

is used at KING STATION MINE

Home of DEEP VEIN COAL

According to Henry P. Smith, of Princeton Mining Company, AIRDOX Methods are used because . . .

AIRDOX

NON-EXPLOSIVE MINING METHOD

Cuts Costs 5 Ways

- Produces less fines in face preparation
- Rolls coal forward for faster, easier loading
- Easier on "tender" roofs—cuts timbering, bolting
- Lowers cleaning costs by minimizing fines
- Reduces degradation—no shattered coal

1 **Safety...** Our miners' safety is uppermost in mind. Also, AIRDOX permits us to shoot while the men are working down below, which is an advantage in the working of the mine.

2 **Preparation...** Deep Vein is primarily a domestic coal and as such must have eye appeal and be able to store with the minimum of degradation — only with the use of AIRDOX is this possible.

HENRY P. SMITH, President
Princeton Mining Company

Mechanization returns greater dividends with

Edison R-4 Cap Lamps on the job

Edison R-4 Electric Cap Lamps can help modern mining machines realize their *full* potential.

Reason why? Because more and better light is always on the job with the brilliant, unfailing beam of the Edison R-4. This dependable source of illumination permits the miner to perform his duties with utmost efficiency and safety. You don't have long to wait for results with the Edison R-4, either. They register quickly in terms of accident prevention and increased tonnage per man-shift.

Let us demonstrate the advantages of this *quality* cap lamp in your underground operation. Write or call us soon for more detailed information.

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